

PROJECT MANUAL FOR:

MEDICAL SCIENCE BUILDING 7TH FLOOR EAST RENOVATION

PROJECT NUMBER: # CP2400920

AT:

**UNIVERSITY OF MISSOURI
COLUMBIA, MISSOURI**

FOR:

THE CURATORS OF THE UNIVERSITY OF MISSOURI

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OPTION 'M' AND OPTION 'L' SPECS

**CONTRACT DOCUMENTS
JULY 08, 2025**

VOLUME 1 OF 1

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I, Steve Cramer, hereby specify that pursuant to RSMO.327.411 the documents intended to be authenticated by my seal are limited to:

SPECIFICATIONS:

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DIVISION 03	CONCRETE
033511	CONCRETE FLOOR FINISHES
DIVISION 04	MASONRY
042200	CONCRETE UNIT MASONRY
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072100	INSULATION
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- 115313 LABORATORY CONTAINMENT DEVICES (FUME HOODS/BIOLOGICAL CABINETS)

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- 122413 ROLLER WINDOW SHADES
- 123553 LABORATORY CASEWORK - FURNITURE AND WORKSURFACES
- 123661 COUNTERTOPS

I hereby certify that these drawings and/or specifications have been prepared by me, or under my supervision. I further certify that to the best of my knowledge these drawings and or specifications are as required by and in compliance with Building Codes of the University of Missouri.

And I hereby disclaim any responsibility for all other plans, specifications, estimates, reports or other documents or instruments relating to or intended to be used for any part or parts for the **MEDICAL SCIENCE BUILDING 7th FLOOR EAST RENOVATION**, PROJECT NO. CP2400920.



DATE: July 08, 2025

END OF CERTIFICATION

SECTION 000004 - STRUCTURAL CERTIFICATION

I, Steven Brooks, hereby specify that pursuant to RSMO.327.411 the documents intended to be authenticated by my seal are limited to:

SPECIFICATIONS:

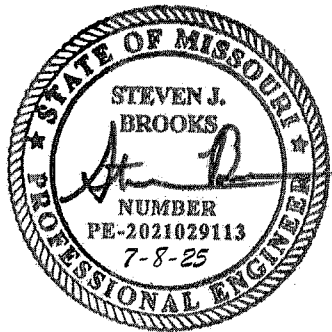
DIVISION 03 CONCRETE
033000 CAST IN PLACE CONCRETE

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DATE: July 8, 2025

END OF CERTIFICATION



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SECTION 000003 - FIRE PROTECTION, PLUMBING, MECHANICAL CERTIFICATION

I, Randy Diemer, hereby specify that pursuant to RSMO.327.411 the documents intended to be authenticated by my seal are limited to:

SPECIFICATIONS:

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210500	COMMON WORK RESULTS FOR FIRE SUPPRESSION
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220529	HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT
220700	PLUMBING INSULATION
221116	DOMESTIC WATER PIPING
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UNIVERSITY OF MISSOURI
MEDICAL SCIENCE BUILDING 7E RENOVATION
CP2400920

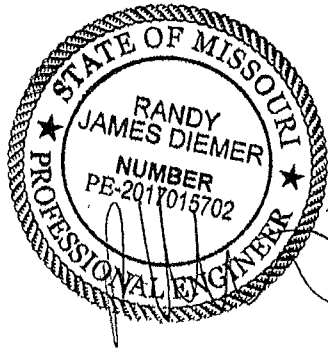
CONTRACT DOCUMENTS
07/08/2025

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DATE: July 8, 2025

END OF CERTIFICATION



SECTION 000005 - ELECTRICAL CERTIFICATION

I, Monica Santos, hereby specify that pursuant to RSMO.327.411 the documents intended to be authenticated by my seal are limited to:

SPECIFICATIONS:

DIVISION 26 ELECTRICAL

- 260500 COMMON WORK RESULTS FOR ELECTRICAL
- 260519 LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES
- 260526 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
- 260529 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS
- 260533 RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS
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- 260544 SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING
- 260548.16 SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS
- 260553 IDENTIFICATION FOR ELECTRICAL SYSTEMS
- 260572 OVERCURRENT PROTECTIVE DEVICE SHORT-CIRCUIT STUDY
- 260573 OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY
- 260574 OVERCURRENT PROTECTIVE DEVICE ARC FLASH STUDY
- 260923 LIGHTING CONTROL DEVICES
- 262200 LOW VOLTAGE TRANSFORMERS
- 262416 PANELBOARDS
- 262726 WIRING DEVICES
- 262813 FUSES
- 262816 ENCLOSED SWITCHES AND CIRCUIT BREAKERS
- 262923 VARIABLE-FREQUENCY MOTOR CONTROLLERS
- 265119 LED INTERIOR LIGHTING
- 265219 EMERGENCY AND EXIT LIGHTING

DIVISION 27 COMMUNICATIONS

- 270500 COMMON WORK RESULTS FOR COMMUNICATIONS
- 270544 SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS AND CABLING

DIVISION 28 FIRE ALARM SYSTEMS

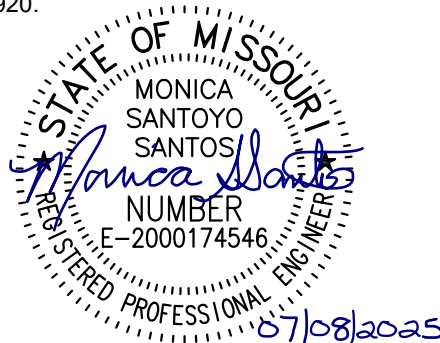
- 283111 DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

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DATE: July 8, 2025

END OF CERTIFICATION



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UNIVERSITY *of* MISSOURI

ENVIRONMENTAL HEALTH AND SAFETY

HAZARDOUS BUILDING MATERIAL SURVEY

CP24000920

MEDICAL SCIENCE BUILDING

MEDICAL SCHOOL FIRE

4/3/2024

TO: Josh Cullen

Pam Eugster

Planning, Design, & Construction

FROM: Pete Kohler

Environmental Health and Safety

MU Environmental Health and Safety has completed a hazardous building material survey of specific areas on the 7th floor of Medical Science Building (Bldg. C37-060). The survey deals with areas of the 7th floor which were impacted by the medical school fire.

The survey was made to identify asbestos-containing material (ACM) which will be disturbed by the upcoming selective demolition and clean-up; and to identify lead paint that might represent a potential worker safety hazard and/or might require special handling and waste disposal prior to the renovation. A list of universal waste is included.

The asbestos inspection was conducted to satisfy the requirements of 40CFR 61, subpart M, which stipulates that all buildings be "thoroughly inspected" for asbestos before the commencement of renovation or demolition activities. The asbestos inspection was conducted by Pete Kohler (MO Asbestos Inspector #10883, expires 10/17/2024), who prepared this report.

The lead survey was conducted by Rudy Zachary (MO Lead Inspector #101220-300003103, expires 12/20/2024).

The survey was conducted in March and April, 2024 and the report was completed April 3, 2024.

Following the fire, an asbestos survey was made by Terracon. Sampling and analysis from the earlier survey were used in preparing this report. Additional sampling was conducted for clarification of suspect material.



Asbestos-containing material was identified in the scope of the project.

Exhaust ducts from fume hoods on lower floors cut through this space. The ductwork is transite, which contains asbestos.

Caulk around the perimeter of a wood, double-hung window in M726 contains asbestos.

FIELD OBSERVATIONS

The walls of the east wing of the 7th floor of Medical Science are cinder block or gypsum panels. The cinder block, its mortar, the gypsum panels, and the sheet rock joint compound were sampled and analyzed, in one or both of the surveys. None of the building materials used in the walls of this space contains asbestos.

The ceiling in this space is a drop ceiling with acoustic ceiling tile in a suspended grid. The ceiling tiles were sampled and analyzed. They are negative for asbestos. Most of the drop ceiling has been removed, to reveal the deck above.

The deck above this space is coffered concrete. There is no spray-on. Ductwork and piping are exposed.

Ductwork that hangs in the ceiling is bare sheet metal or insulated with fiberglass. Much of the material associated with the ducts is melted and damaged. Some caulk or sealant remains. Caulk from the ductwork exterior was sampled and analyzed. It is negative for asbestos. Material from a penetration where pipe goes through concrete was sampled and found negative for asbestos.

Piping that runs through the ceiling is bare or is insulated with fiberglass. A significant amount of the piping, particularly in M708, is stickered with asbestos warnings. Several samples of the insulation were analyzed, to verify that the stickers are incorrect. No asbestos was identified in the pipe insulation. I checked pipes fittings and valves, trying to find any hard mud that may have been used. I found none. I checked the length of the straight runs as well, to make sure no mud had been used at seams between straights, or at hangers. There is no hard mud used. The pipe insulation is negative for asbestos.

Fume hoods in this area are not transite. The interior panels are negative for asbestos. The ducts for these hoods are stainless steel. Cabinets that the hoods sit on do not contain asbestos.

Ducts from hoods on the floors below run through this space. Some are transite, which contains asbestos. Some of the transite ducts ran inside chases which are now demolished.





An asbestos abatement containment is currently set up in M710/M710A. Alloy, the abatement company for the main Med Sci project has set up to work on large transite ductwork.

The flooring in this wing is 12" floor tile on concrete, or poured epoxy flooring, or bare concrete. Terracon sampled two different floor tiles. Analysis was by PLM and they are negative for asbestos. I collected samples of the two 12" styles of tile and had them analyzed using TEM, which is the more rigorous analysis method. Findings corroborate that the floor tile is negative for asbestos.

Mastic on the floor tile is blond which is not suspect material. Terracon had the mastic analyzed and it is negative for asbestos.

The poured epoxy lab floor was found negative for asbestos as well. No asbestos concerns exist in the flooring of this area.

Counter tops for laboratories appear uniform throughout the area. Samples collected by Terracon were analyzed and found negative for asbestos. Black lab sinks are slightly heavier material. I collected samples of two sinks for analysis. They, too, are negative for asbestos.

The windows for this area have been switched to new aluminum inserts. The old wood, double-hungs have been removed, along with the positive caulk that has been found throughout the Medical Science Building. There is one exception: a single window in mechanical space M726, which is specifically called out on the floor plans as within the scope of the project. The window is the old, wood double-hung style. The window is inoperable. It is presumed that the caulk used around the perimeter of the frame is positive for asbestos. This application on these windows has been tested many times throughout Medical Science and the caulk is positive for asbestos. The window glazing compound has tested negative for asbestos.



The doors in this area are not fire rated. One door, off its hinges and lying loose in a lab, had an exposed structure that included suspect material. I collected a sample of the door interior for analysis. It is negative for asbestos.

ASBESTOS SUMMARY

One wood window in M726 has ACM caulk around the perimeter of its frame – Ten (10) linear feet.
Seven transite ducts from fume hoods on lower floors cut through the space of the project area – One hundred fourteen (114) linear feet.

SAMPLE ID	LOCATION/DESCRIPTION	ANALYSIS
240326-01	708A Med Sci, TSI – duct exterior	100% non-fibrous
240327-01	M708 Med Sci, 12" white floor tile (blond mastic – no analysis)	100% matrix material
240327-02	M708 Med Sci, TSI – 3" straight (at end of straight run)	93% mineral wool, 7% non-fibrous
240327-03	M708 Med Sci, 12" white floor tile (darker specks), (blond mastic – no analysis)	100% matrix material
240327-04	M708 Med Sci, interior panel from fume hood	37% glass, 63% non-fibrous
240327-05	M708B-2 Med Sci, sealant on concrete ceiling (black caulk?)	100% non-fibrous
240327-06	M708 Med Sci, TSI – 3" straight – repair (wetable cloth with Vimasco)	Coating – 100% non-fibrous Fabric wrap – 88% glass, 12% non-fibrous
240327-07	M708 Med Sci – black lab sink	100% non-fibrous
240327-08	M706 Med Sci – black lab sink	100% non-fibrous
240402-01	M706 Med Sci, door- interior of lab door – side post	30% cellulose, 20% mica, 50% non-fibrous

UNIVERSAL WASTE

In addition to the material identified as asbestos-containing, the following items should be collected and disposed of correctly. MU EHS Resource Recovery (882-3736) can help with this. They will provide containers for fluorescent light fixtures and bulbs; and will pick up this material when it has been collected.

In M704, there are ten freezers and refrigerators and one ice machine operating, as research equipment. There are two refrigerators operating in M705, for storage of food. These rooms were minimally affected by the fire and are still in use. If the equipment is to be discarded, the refrigerant gases must be evacuated by qualified technicians before disposal.

The three freezers and refrigerators in the labs that were impacted by the fire must be serviced by qualified technicians before they are discarded.



A number of door closers have been removed from their doors and are loose in Lab M708. It is possible that other closers may be found under piles of debris as the clean-up progresses. Damaged fluorescent light fixtures have been taken down. Any closers, fluorescent bulbs, or ballasts from fluorescent fixtures must be collected as universal waste and disposed of properly.

Two hundred thirty one (231) four foot fluorescent bulbs
Eighty five (85) ballasts from fluorescent light fixtures
Three (3) exit signs
One (1) emergency fire strobe
Fourteen (14) door closers

Three (3) refrigerators/freezers must have refrigerant gas evacuated by qualified technicians

LEAD SURVEY

Finished surfaces were tested for lead, using a Niton XRF analyzer. The XRF was checked before the survey and found to be in calibration.

The EPA and the U.S. Department of Housing and Urban Development (HUD) consider lead-based paint as containing a lead concentration equal to or greater than 1.0 milligram per square centimeter (mg/cm²) or 0.5% lead by weight, as defined by Title X of the 1992 Housing and Community Development Act. The US Consumer Product Safety Commission considers paint with up to 600 ppm of lead to be "Lead Free".

OSHA has found that certain work, including aggressive disturbance of the painted surface, may result in lead levels exceeding the Action Level or Permissible Exposure Limit (PEL) – even when the concentration of lead is below 1 mg/cm².

LEAD SUMMARY

The surfaces of the area we checked on 7th floor of Medical Science do not have lead-based finishes.



LOCATION/DESCRIPTION	LEAD READINGS (mg/cm ²)
Rooms M706, M707 Painted concrete & drywall wall sections *(rooms M704 and M705 were not impacted)	Cinderblock wall sections white paint M706 0.02, 0.03, 0.01, 0.03, 0.01, 0.01 Painted concrete deck 0.03, 0.02, 0.04, 0.01, 0.01 - Door - Varnished wood - 0.02, 0.02 - Door Frame - 0.02, 0.03 M707 (Drywall & Cinderblock wall sections white paint) 0.02, 0.02, 0.04, 0.01, 0.03
Rooms M708, M708A, M708A1, M708A2, M708A3, 708A4 Painted concrete & drywall wall sections	Room M708: Wall sections cinderblock white paint 0.02, 0.04, 0.02, 0.01, 0.02, 0.02, Concrete deck white paint 0.03, 0.02 Entrance door - 0.01, 0.01 Door frame - 0.01, 0.01 Debris on floor damaged cinderblock 0.03, 0.02 Rooms M708A, M708A1, M708A2, M708A3 Wall sections cinderblock and drywall white paint 0.01, 0.03, 0.01, 0.01, 0.03, 0.05, 0.01, 0.03, 0.02, 0.01, 0.02, 0.03, 0.03, 0.01, 0.02, 0.03 Entrance doors - 0.01, 0.03, 0.02, 0.03 Door frames - 0.01, 0.02, 0.02, 0.02, 0.01, 0.03, 0.02, 0.01 Concrete deck white paint 0.01, 0.02
Rooms 708B, M708B1, M708B2	Room M708B, M708B1, M708B2: Wall sections Cinderblock white paint 0.03, 0.01, 0.01, 0.03, 0.03, 0.01, 0.02, 0.01, 0.03 Concrete Deck white paint 0.03, 0.05, 0.02, 0.01, 0.02, 0.01 Entrance door - 0.01, 0.01, 0.02 Door frame - 0.01, 0.02, 0.02, 0.02, 0.03, 0.01



Rooms M710, M710A, M710B, M711, M712	Rooms M710, M710A, M710B, M711, M712, (room 710A not accessible - asbestos abatement in progress) Wall sections Cinderblock white paint 0.02, 0.03, 0.03, 0.01, 0.04, 0.01, 0.01, 0.03, 0.02, 0.03, 0.02, 0.04, 0.01, 0.03, 0.02, 0.03, 0.01, 0.01, 0.02, 0.03 Concrete Deck white paint 0.03, 0.05, 0.02, 0.01, 0.02, 0.01 Entrance door - 0.01, 0.01, 0.02, 0.02, 0.03 Door frame - 0.01, 0.02, 0.02, 0.02, 0.03, 0.01, 0.01, 0.01



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PLANNING DESIGN & CONSTRUCTION

900 E. Stadium, Ste. 130
Columbia, Missouri 65211
Telephone: (573) 882-6800

ADVERTISEMENT FOR BIDS

Sealed bids for:

MEDICAL SCIENCE BUILDING –
7E RENOVATION

UNIVERSITY OF MISSOURI
COLUMBIA, MISSOURI

PROJECT NUMBER: CP2400920

CONSTRUCTION ESTIMATE: \$3,343,500 - \$3,715,000

will be received by the Curators of the University of Missouri, Owner, at Planning, Design & Construction, Room L100 (Front Reception Desk), General Services Building, University of Missouri, Columbia, Missouri 65211, until 1:30 p.m., C.T., July 29, 2025 and then immediately opened and publicly read aloud.

Drawings, specifications, and other related contract information may be obtained at <http://operations-webapps.missouri.edu/pdc/adsite/ad.html>. Electronic bid sets are available at no cost and may be printed as desired by the plan holders. No paper copies will be issued. If paper copies are desired, it is the responsibility of the user to print the files or have them printed.

Questions regarding the scope of work should be directed to Steve Cramer with Peckham Guyton Albers & Viets, Inc. at (913) 362-6500 or steve.cramer@pgav.com. Questions regarding commercial conditions should be directed to Pam Eugster at (573) 882-1444 or eugsterpj@umsystem.edu.

A prebid meeting will be held at 9:00 a.m., C.T., July 16, 2025 in the General Services Bldg., Room 194B, followed by a site walk-through.

A Diversity Participation goal of 10% MBE, 10% WBE and 3% SDVE has been established for this contract.

The Owner reserves the right to waive informalities in bids and to reject any and all bids.

Individuals with special needs as addressed by the Americans with Disabilities Act may contact (573) 882-6800.

Advertisement Date: July 8, 2025

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SECTION 1.A

BID FOR LUMP SUM CONTRACT

Date: _____

BID OF _____

(hereinafter called "Bidder") a corporation * organized and existing under laws of the State of _____,

A partnership * consisting of _____,

An individual* trading as _____,

A joint venture* consisting of _____

*Insert Corporations(s), partnership or individual, as applicable.

TO: Curators of the University of Missouri
c/o Associate Vice Chancellor – Facilities
Room L100, General Services Building
University of Missouri
Columbia, Missouri 65211

1. Bidder, in compliance with invitation for bids for construction work in accordance with Drawings and Specifications prepared by Peckham Guyton Albers & Viets, Inc., entitled "MEDICAL SCIENCE BUILDING 7E RENOVATION" project number CP2400920, dated July 8, 2025 having examined Contract Documents and site of proposed work, and being familiar with all conditions pertaining to construction of proposed project, including availability of materials and labor, hereby proposed to furnish all labor, materials and supplies to construct project in accordance with Contract Documents, within time set forth herein at prices stated below. Prices shall cover all expenses, including taxes not covered by the University of Missouri's tax exemption status, incurred in performing work required under Contract documents, of which this Bid is a part.

Bidder acknowledges receipt of the following addenda:

Addendum No. _____ Dated _____

Addendum No. _____ Dated _____

Addendum No. _____ Dated _____

Addendum No. _____ Dated _____

2. In the following Bids, amounts shall be written in both words and figures. In case of discrepancy between words and figures, words shall govern. Bidders shall provide bids for all base bid options and all bid alternates listed on the bid form.

3. BID PRICING

a. **Base Bid Option 'L'**

The Bidder agrees to furnish all labor, materials, tools, and equipment required to renovate CP2400920 Medical Science Building 7E Renovation; all as indicated on the Drawings titled **Option 'L'** and described in these Specifications for a sum of:

_____ DOLLARS (\$ _____).

b. **Base Bid Option 'M'**

The Bidder agrees to furnish all labor, materials, tools, and equipment required to renovate CP2400920 Medical Science Building 7E Renovation; all as indicated on the Drawings titled **Option 'M'** and described in these Specifications for a sum of:

_____ DOLLARS (\$ _____).

c. **Option 'L' Additive Alternate Bids:**

Above Option 'L' Base Bid may be changed in accordance with the following Alternate Bids at Owner's discretion. Alternates are as described in Section 1.H of the Project Manual. Alternates are written in a priority order, but Owner is not required to accept or reject in order listed. This is a one (1) contract project, therefore, Alternates shall be studied by each Bidder to determine effect on Bids of Contractor and each Subcontractor and/or Material supplier.

(1) Additive Alternate No. L1: LED Light Fixtures in Lieu of Fluorescent Fixtures

Provide new LED light fixtures in lieu of fluorescent tube retrofit fixtures as indicated, all for the sum of:

_____ DOLLARS (\$ _____).

(2) Additive Alternate No. L2: Replace Additional Ductwork:

Remove and replace existing ductwork outside of primary renovation area

where indicated on mechanical drawings, and provide new LED light fixtures and ceilings in these areas as indicated on architectural and electrical drawings, all for the sum of:

_____. DOLLARS (\$ _____).

d. **Option 'M' Additive Alternate Bids:**

Above Option 'M' Base Bid may be changed in accordance with the following Alternate Bids at Owner's discretion. Alternates are as described in Section 1.H of the Project Manual. Alternates are written in a priority order, but Owner is not required to accept or reject in order listed. This is a one (1) contract project, therefore, Alternates shall be studied by each Bidder to determine effect on Bids of Contractor and each Subcontractor and/or Material supplier.

(1) Additive Alternate No. M1: Additional Fire Protection Area 1A

Provide additional fire protection system as shown on FP drawings for existing Area 1A – Green areas on architectural sheet A375M. Connect existing fire sprinkler piping to system & install heads. Temporarily support ceilings, lighting, and ceiling mounted devices in this area. All for the sum of:

_____. DOLLARS (\$ _____).

(2) Additive Alternate No. M2: Additional Fire Protection Area 1B

Provide additional fire protection system as shown on FP drawings for existing Area 1B – Blue area on architectural sheet A375M. Install all new sprinkler system (no existing piping). Temporarily support ceilings, lighting, and ceiling mounted devices in this area. All for the sum of:

_____. DOLLARS (\$ _____).

(3) Additive Alternate No. M3: Men's & Women's Restroom Renovation

Provide demolition and renovation of existing Men's and Women's restrooms as indicated on drawings. All for the sum of:

_____. DOLLARS (\$ _____).

(4) Additive Alternate No. M4: Plumbing Rework in Lab M702 & Corridor M723

Provide demolition and rework of existing plumbing piping in Lab M702 & Corridor M723 as indicated, all for the sum of:

_____ DOLLARS (\$ _____).

(5) Additive Alternate No. M5: Plumbing Rework in NE Corridor M727

Provide demolition and rework of existing plumbing piping in Northeast Corridor M723 as indicated, all for the sum of:

_____ DOLLARS (\$ _____).

4. PROJECT COMPLETION

- a. Contract Period – Contract period begins on the day the Contractor receives unsigned Contract, Performance Bond, Payment Bond, and “Instructions for Execution of Contract, Bonds, and Insurance Certificates.” Bidder agrees to complete project within three hundred twenty-three (323) calendar days from receipt of aforementioned documents. Fifteen (15) calendar days have been allocated in construction schedule for receiving aforementioned document from Bidder.
- b. Commencement – Contractor agrees to commence work on this project after the “Notice to Proceed” is issued by the Owner. “Notice to Proceed” will be issued within seven (7) calendar days after the Owner receives properly prepared and executed Contract documents listed in paragraph 4.a. above.
- c. Special Scheduling Requirements – refer to special scheduling requirements described in the Special Conditions 1.E.

5. SUBCONTRACTOR LIST:

Bidder hereby certifies that the following subcontractors will be used in performance of Work:

NOTE: Failure to list subcontractors for each category of work identified on this form or listing more than one subcontractor for any category of work without designating the portion of work performed by each shall be grounds for rejection of bid. List name, city, and state of designated subcontractor, for each category of work listed in Bid For Lump Sum Contract. If work within a category will be performed by more than one subcontractor, Bidder shall provide name, city, and state of each subcontractor and specify exact portion of work to be performed by each. If acceptance/non-acceptance of Alternates will affect designation of a subcontractor, Bidder shall provide information, for each affected category, with this bid form. If Bidder intends to perform

any designated subcontract work by using Bidder's own employees, then Bidder shall list their own name, city, and state. The bidder may petition the Owner to change a listed subcontractor only within 48 hours of the bid opening. See Information For Bidders Section 16 List of Subcontractors for requirements.

Work to be performed: Subcontractor Name, City, and State

- a. Mechanical: _____
- b. Electrical: _____

6. SUPPLIER DIVERSITY PARTICIPATION GOALS

- a. MBE/WBE/SDVE Participation Goals: The Bidder shall have a goal of providing participation in the contract of Minority Business Enterprises (MBE) of ten percent (10%) with Women Business Enterprises (WBE) of ten percent (10%) and with Service-Disabled Veteran Business Enterprises (SDVE) of three percent (3%) of the awarded contract price for work to be performed.
- b. Good Faith Effort Waiver: Requests for waiver of these goals due to good faith effort shall be submitted on the attached Application For Waiver form. A determination by the UM Executive Director of Facilities Planning and Development that a good faith effort has not been made by Bidder to achieve the above stated goals may result in rejection of the bid.
- c. The undersigned Bidder proposes to perform work with the MBE/WBE/SDVE participation level set forth below. An MBE/WBE/SDVE Compliance Evaluation form shall be submitted with this bid for each MBE/WBE/SDVE subcontractor to be used on this project.

MBE PERCENTAGE PARTICIPATION:

_____ percent (_____%)

WBE, DBE, and/or VETERAN PERCENTAGE PARTICIPATION

_____ percent (_____%)

SDVE PERCENTAGE PARTICIPATION:

_____ percent (_____%)

- a. A Supplier Diversity Compliance Evaluation form shall be submitted with this bid for each diverse subcontractor to be used on this project.

7. BIDDER'S ACKNOWLEDGEMENTS

- a. Bidder declares that he has had an opportunity to examine the site of the work and he has examined Contract Documents therefore; that he has carefully prepared his bid upon the basis thereof; that he has carefully examined and checked bid, materials, equipment and labor required thereunder, cost thereof, and his figures therefore. Bidder hereby states that amount, or amounts, set forth in bid is, or are, correct and that no mistake or error has occurred in bid or in Bidder's computations upon which this bid is based. Bidder agrees that he will make no claim for reformation, modifications, revisions or correction of bid after scheduled closing time for receipt of bids.
- b. Bidder agrees that bid shall not be withdrawn for a period of ninety (90) days after scheduled closing time for receipt of bids.
- c. Bidder understands that Owner reserves right to reject any or all bids and to waive any informalities in bidding.
- d. Accompanying the bid is a bid bond, or a certified check, or a cashier's check payable without condition to "The Curators of the University of Missouri" which is an amount at least equal to five percent (5%) of amount of largest possible total bid herein submitted, including consideration of Alternates.
- e. Accompanying the bid is a Bidder's Statement of Qualifications. Failure of Bidder to submit the Bidder's Statement of Qualifications with the bid may cause the bid to be rejected. Owner does not maintain Bidder's Statements of Qualifications on file.
- f. It is understood and agreed that bid security of two (2) lowest and responsive Bidders will be retained until Contract has been executed and an acceptable Performance Bond and Payment Bond has been furnished. It is understood and agreed that if the bid is accepted and the undersigned fails to execute the Contract and furnish acceptable Performance/Payment Bond as required by Contract Documents, accompanying bid security will be realized upon or retained by Owner. Otherwise, the bid security will be returned to the undersigned.

8. BIDDER'S CERTIFICATE

Bidder hereby certifies:

- a. His bid is genuine and is not made in interest of or on behalf of any undisclosed person, firm or corporation, and is not submitted in conformity with any agreement or rules or any group, association or corporation.
- b. He has not directly or indirectly induced or solicited any other bidder to put in a false or sham bid.
- c. He has not solicited or induced any person, firm or corporation to refrain from bidding.
- d. He has not sought by collusion or otherwise to obtain for himself any advantage over

any other Bidder or over Owner.

- e. He will not discriminate against any employee or applicant for employment because of race, color, religion, sex or national origin in connection with performance of work.
- f. By virtue of policy of the Board of Curators, and by virtue of statutory authority, a preference will be given to materials, products, supplies, provisions and all other articles produced, manufactured, mined or grown within the State of Missouri. By virtue of policy of the Board of Curators, preference will also be given to all Missouri firms, corporations, or individuals, all as more fully set forth in "Information For Bidders."

END OF BIDDER'S CERTIFICATE

9. BIDDER'S SIGNATURE

Note: All signatures shall be original; not copies, photocopies, stamped, etc.

Authorized Signature	Date
Printed Name	Title
Company Name	
Mailing Address	
City, State, Zip	
Phone No.	
Fax No.	E-Mail Address
Circle one: Individual Partnership Corporation Joint Venture	
If a corporation, incorporated under the laws of the State of _____	
Licensed to do business in the State of Missouri? ____yes ____no	

(Each Bidder shall complete bid form by manually signing on the proper signature line above and supplying required information called for in connection with the signature. Information is necessary for proper preparation of the Contract, Performance Bond and Payment Bond. Each Bidder shall supply information called for in accompanying "Bidder's Statement of Qualifications.")

END OF SECTION

**UNIVERSITY OF MISSOURI
BIDDER'S STATEMENT OF QUALIFICATIONS**

Submit with Bid for Lump Sum Contract in separate envelope appropriately labeled. Attach additional sheet if necessary.

1. Company Name _____
Phone# _____ Fax #: _____
Address _____
2. Number of years in business _____. If not under present firm name, list previous firm names and types of organization.

3. List contracts on hand (complete the following schedule, include telephone number).

Project & Address	Owner/Owner's Representative	Phone Number	Architect	Amount of your Contract	Percent Completed
4. General character of work performed by your company personnel.

5. List important projects completed in the last five (5) years on a type similar to the work now bid for, including approximate cost and telephone number.

Project & Address	Owner/Owner's Representative	Phone Number	Architect	Amount of your Contract	Percent Completed
6. Other experience qualifying you for the work now bid.

7. No default has been made in any contract complete or incomplete except as noted below:
 - (a) Number of contracts on which default was made _____
 - (b) Description of defaulted contracts and reason therefor _____

8.
 - (a) Have you or your company participated in any contract subject to an equal opportunity clause similar to that described in the General Conditions?
Yes _____ No _____
 - (b) Have you filed all required compliance reports?
Yes _____ No _____

- (c) Is fifty percent or more of your company owned by a minority?
Yes _____ No _____
- (d) Is fifty percent or more of your company owned by a woman?
Yes _____ No _____
- (e) Is fifty percent or more of your company owned by a service disabled veteran?
Yes _____ No _____
- (f) Is fifty percent or more of your company owned by a veteran?
Yes _____ No _____
- (g) Is your company a Disadvantaged Business Enterprise?
Yes _____ No _____

9. Have you or your company been suspended or debarred from working at any University of Missouri campus?

Yes _____ No _____ (If the answer is "yes", give details.)

10. Have any administrative or legal proceedings been started against you or your company alleging violation of any wage and hour regulations or laws?

Yes _____ No _____ (If the answer is "yes", give details.)

11. Workers Compensation Experience Modification Rates (last 3 yrs): _____ / _____ / _____

Incidence Rates (last 3 years): _____ / _____ / _____

12. List banking references.

13. (a) Do you have a current confidential financial statement on file with Owner?
Yes _____ No _____ (If not, and if desired, Bidder may submit such statement with bid, in a separate sealed and labeled envelope.)

(b) If not, upon request will you file a detailed confidential financial statement within three (3) days?
Yes _____ No _____

Dated at _____ this _____ day of _____ 20____

Name of Organization

Signature

Printed Name

Title of Person Signing

END OF SECTION

SUPPLIER DIVERSITY COMPLIANCE EVALUATION FORM

This form shall be completed by Bidders and submitted with the Bidder's Statement of Qualifications form for each diverse firm who will function as a subcontractor on the contract.

The undersigned submits the following data with respect to this firm's assurance to meet the goal for Supplier Diversity participation.

- I. Project: _____
- II. Name of General Contractor: _____
- III. Name of Diverse Firm: _____
Address: _____
Phone No.: _____ Fax No.: _____
Status (check one) MBE _____ WBE _____ Veteran _____ Service Disabled Veteran _____ DBE _____
- IV. Describe the subcontract work to be performed. (List Base Bid work and any Alternate work separately):
Base Bid: _____

- V. Dollar amount of contract to be subcontracted to the Diverse firm:
Base Bid: _____
Alternate(s), (Identify separately): _____

- VI. Is the proposed subcontractor listed in the Directory of M/W/DBE Vendors, Directory of Served Disabled Veterans and/or the Directory of Veterans maintained by the State of Missouri?
Yes _____ No _____

Is the proposed subcontractor certified as a diverse supplier by any of the following: federal government agencies, state agencies, State of Missouri city or county government agencies, Minority and/or WBE certifying agencies?

Yes _____

No _____

If yes, please provide details and attach a copy of the certification.

Does the proposed subcontractor have a signed document from their attorney certifying the Supplier as a Diverse and meeting the 51% owned and committed requirement?

Yes _____

No _____

If yes, please attach letter.

Signature: _____

Name: _____

Title: _____

Date: _____

APPLICATION FOR WAIVER

This form shall be completed and submitted with the Bidder's Statement of Qualifications. Firms wishing to be considered for award are required to demonstrate that a good faith effort has been made to include diverse suppliers. This form will be used to evaluate the extent to which a good faith effort has been made. The undersigned submits the following data with respect to the firm's efforts to meet the goal for Supplier Diversity Participation.

1. List pre-bid conferences your firm attended where Supplier Diversity requirements were discussed.

2. Identify advertising efforts undertaken by your firm which were intended to recruit potential diverse subcontractors for various aspects of this project. Provide names of newspapers, dates of advertisements and copies of ads that were run.

3. Note specific efforts to contact in writing those diverse suppliers capable of and likely to participate as subcontractors for this project.

4. Describe steps taken by your firm to divide work into areas in which diverse suppliers/contractors would be capable of performing.

5. What efforts were taken to negotiate with prospective diverse suppliers/contractors for specific sub-bids? Include the names, addresses, and telephone numbers of diverse suppliers/contractors contacted, a description of the information given to diverse suppliers/contractors regarding plans and specifications for the assigned work, and a statement as to why additional agreements were not made with diverse suppliers/contractors.

6. List reasons for rejecting a diverse supplier/contractor which has been contacted.

8. Describe the follow-up contacts with diverse suppliers/contractors made by your firm after the initial solicitation.

9. Describe the efforts made by your firm to provide interested diverse suppliers/contractors with sufficiently detailed information about the plans, specifications and requirements of the contract.

10. Describe your firm's efforts to locate diverse suppliers/contractors.

Based on the above stated good faith efforts made to include supplier diversity, the bidder hereby requests that the original supplier diversity percentage goal be waived and that the percentage goal for this project be set at _____ percent.

The undersigned hereby certifies, having read the answers contained in the foregoing Application for Waiver, that they are true and correct to the best of his/her knowledge, information and belief.

Signature_____

Name_____

Title_____

Company_____

Date_____

AFFIDAVIT

"The undersigned swears that the foregoing statements are true and correct and include all material information necessary to identify and explain the operation of _____ (name of firm) as well as the ownership thereof. Further, the undersigned agrees to provide through the prime contractor or directly to the Contracting Officer current, complete and accurate information regarding actual work performed on the project, the payment therefore and any proposed changes, if any, of the project, the foregoing arrangements and to permit the audit and examination of books, records and files of the named firm. Any material misrepresentation will be grounds for terminating any contract which may be awarded and for initiating action under federal or state laws concerning false statements."

Note - If, after filing this information and before the work of this firm is completed on the contract covered by this regulation, there is any significant change in the information submitted, you must inform the Director of Facilities Planning and Development of the change either through the prime contractor or directly.

Signature _____

Name _____

Title _____

Date _____

Corporate Seal (where appropriate)

Date _____

State of _____

County of _____

On this _____ day of _____, 19_,
before me appeared (name) _____ to me personally known, who, being
duly sworn, did execute the foregoing affidavit, and did state that he or she was properly authorized by (name of firm)

_____ to execute the affidavit and did so as his or her own free act and deed.

(Seal)

Notary Public _____

Commission expires _____

AFFIDAVIT FOR AFFIRMATIVE ACTION

State of Missouri)
)
County of) ss.

_____ first being duly sworn on his/her oath
states: that he/she is the (sole proprietor, partner, or officer) of _____
_____ a (sole proprietorship, partnership, corporation), and as such (sole proprietor, partner, or officer) is
duly authorized to make this affidavit on behalf of said (sole proprietorship, partnership, corporation); that under the contract
known as " _____ "
Project No. _____ less than 50 persons in the aggregate will be employed and therefore, the applicable Affirmative
Action requirements as set forth in the "Nondiscrimination in Employment Equal Opportunity," Supplemental Special
Conditions, and Article 13 in the General Conditions do not apply.

Subscribed and sworn before me this _____ day of _____, 19_____.

My commission expires _____, 19_____.

CERTIFYING SUPPLIER DIVERSITY AGENCIES

Diverse firms are defined in General Conditions Articles 1.1.7 and those businesses must be certified as disadvantaged by an approved agency. The Bidder is responsible for obtaining information regarding the certification status of a firm. A list of certified firms may be obtained by contacting the agencies listed below. Any firm listed as disadvantaged by any of the following agencies will be classified as a diverse firm by the Owner.

St. Louis Development Corporation
1520 Market St., Ste. 2000
St. Louis, MO 63103
P: 314.982.1400
W: www.stlouis-mo.gov/slhc/

Bi-State Development
211 N. Broadway, Ste. 700
St. Louis, MO 63102
P: 314.982.1400
W: www.metrostlouis.dbesystem.com

St. Louis Minority Business Council
211 N. Broadway, Ste. 1300
St. Louis, MO 63102
P: 314.231.5555
W: www.slmhc.org

U.S. Small Business Administration - St. Louis, MO
8(a) Contractors, Minority Small Business
1222 Spruce Street, Suite 10.103
St. Louis, MO 63101
P: 314.539.6600
W: www.sba.gov

Lambert St. Louis International Airport
Business Diversity Development Office
11495 Navaid
Bridgeton, MO 63044
P: 314-426-8111
W: www.flystl.com/business/business-diversity-development-1/directories

City of Kansas City, Missouri
Human Relations Department, MBE/WBE Division
4th Floor, City Hall
414 E. 12th Street
Kansas City, MO 64106
P: 816.513.1836
W: kcmohrd.mwdbe.com/?TN=kcmohrd

Mid-States Minority Supplier Development Council
505 N. 7th Street, Ste. 1820
St. Louis, MO 63101
P: 314.278.5616
W: midstatesdc.org

U.S. Small Business Administration - Kansas City, MO
8(a) Contractors, Minority Small Business
1000 Walnut, Suite 500
Kansas City, MO 64106
P: 816.426.4900
W: kcmohrd.mwdbe.com/?TN=kcmohrd

Missouri Department of Transportation
Division of Construction
1617 Missouri Blvd.
P.O. Box 270
Jefferson City, MO 65102
P: 573.526.2978
W: www.modot.org/mrcc-directory

Illinois Department of Transportation
MBE/WBE Certification Section
2300 Dirksen Parkway
Springfield, IL 62764
217/782-5490; 217/785-1524 (Fax)
W: webapps.dot.illinois.gov/UCP/ExternalSearch

State of Missouri OA
Office of Equal Opportunity
301 W. High St. HSC Rm 870-B
Jefferson City, MO 65101
P: 877.259.2963
W: oa.mo.gov/sites/default/files/sdvelisting.pdf
oeo.mo.gov/

Minority Newspapers

Dos Mundos Bilingual Newspaper

902A Southwest Blvd.
Kansas City, MO 64108
816-221-4747
www.dosmundos.com

Kansas City Hispanic News

2918 Southwest Blvd.
Kansas City, MO 64108
816/472-5246
www.kchispanicnews.com

The Kansas City Globe

615 E. 29th Street
Kansas City, MO 64109
816-531-5253
www.thekcglobe.com/about_us.php

St. Louis American

4144 Lindell
St. Louis, MO 63108
314-533-8000
www.stlamerican.com

St. Louis Chinese American News

1766 Burns Ave, Suite 201
St. Louis, MO 63132
314-432-3858
www.scanews.com

St. Louis Business Journal

815 Olive St., Suite 100
St. Louis, MO 63101
314-421-6200
www.bizjournal.com/stlouis

Kansas City Business Journal

1100 Main Street, Suite 210
Kansas City, MO 64105
816-421-5900
www.bizjournals.com/kansascity

AFFIDAVIT OF SUPPLIER DIVERSITY PARTICIPATION

The apparent low Bidder shall complete and submit this form within 48 hours of bid opening for each Diverse firm that will participate on the contract.

1. Diverse Firm: _____

Contact Name: _____

Address: _____

Phone No.: _____ E-Mail: _____

Status (check one) MBE ☐ WBE ☐ Veteran ☐ Service Disabled Veteran ☐ DBE ☐

If MBE, Certified as (circle one): 1) Black American 2) Hispanic American 3) Native American 4) Asian American

2. Is the proposed diverse firm certified by an approved agency [see IFB article 15]? Yes ☐ No ☐

Agency: _____ [attach copy of certification authorization from agency]

Certification Number: _____

3. Diverse firm scope work and bid/contract dollar amount of participation (List Base Bid and Alternate work separately). The final Dollar amount will be determined at substantial completion:

	Scope of Work	Bid/Contract Amount	Final Dollar Amount
Base Bid			
Alternate #1			
Alternate #2			
Alternate #3			
Alternate #4			
Alternate #5			
Alternate #6			

The undersigned certifies that the information contained herein (i.e. Scope of Work and Bid/Contract Amount) is true and correct to the best of their knowledge, information and belief.

General Contractor: _____ Diverse Firm: _____

Signature: _____ Signature: _____

Name: _____ Name: _____

Title: _____ Title: _____

Date: _____ Date: _____

The undersigned certifies that the information contained herein (i.e. Scope of Work and Final Dollar Amount) is true and correct to the best of their knowledge, information and belief. If the Final Dollar Amount is different than the Bid/Contract Amount, then attach justification for the difference.

Contractor: _____ Diverse Firm: _____

Signature: _____ Signature: _____

Name: _____ Name: _____

Title: _____ Title: _____

Date: _____ Date: _____

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University of Missouri

INFORMATION FOR BIDDERS

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1. Contract Documents and Definitions

1.1 The “Drawings,” “Specifications,” and “Contract Documents” are defined in the “General Conditions of the Contract for Construction.”

1.2 The Drawings, Specifications, and other Contract Documents may be obtained as indicated in the Advertisement for Bids.

1.3 As used herein, “Bid” refers to an offer or proposal submitted to the Owner to enter into a contract for the work identified in the Drawings, Specifications and other Contract Documents.

1.4 As used herein, “Bidder” means an individual or business entity that submits a Bid to the Owner as a prime bidder or general contractor.

1.5 All other terms used herein shall have the meanings defined herein or in the General Conditions of the Contract for Construction or other Contract Documents.

2. Bidder Obligations

2.1 Before submitting a Bid, each Bidder shall carefully examine the Drawings and Specifications and related Contract Documents, visit the site of the work, and fully inform themselves as to all existing conditions, facilities, restrictions, and other matters that could affect the work or the cost thereof.

2.2 Each Bidder shall include in their Bid the cost of all work and materials required to complete the contract in a first-class manner, as specified in the Drawings, Specifications, and other Contract Documents. All work shall be done as defined in the Specifications and as indicated on the Drawings.

2.3 Failure or omission of any Bidder to receive or to examine any form, instrument, addendum, or other document, or to visit the site of the work and acquaint themselves with existing conditions, shall in no way relieve the Bidder from any obligation with respect to their Bid or any awarded contract. No extra compensation will be allowed concerning any matter about which the Bidder should have fully informed themselves prior to submitting a Bid.

2.4 Submission of a Bid shall be deemed acceptance by the Bidder of the above obligations and every obligation required by the Contract Documents in the event the Bid is accepted by the Owner.

3. Interpretation of Documents

3.1 If any prospective Bidder is in doubt about the meaning of any part of the Drawings, Specifications, or

other Contract Documents, the Bidder shall submit a written request to the Architect for an interpretation.

3.2 Any request for interpretation shall be delivered to the Architect at least one (1) week prior to time for receipt of bids.

3.3 A Bid shall be based only on an interpretation issued in the form of an addendum mailed to each person or business entity that is on the Architect’s record as having received a set of the Contract Documents.

3.4 Bidders shall not be entitled to rely on oral interpretations or written statements not issued in an addendum from either the Architect or a representative, agent, or employee of the Owner.

4. Bids

4.1 Bids shall be submitted on a single “Bid for Lump Sum Contract” form (“Bid Form”) as furnished by the Owner or Architect. Bids shall be received separately or in combination as required by Bid Form

4.2 In addition to the Bid Form, the Bid shall include any documents or information required to be submitted by this Information for Bidders or the Contract Documents.

4.3 Bids shall include amounts for alternate bids, unit prices, and cost accounting data where required by the Bid Form.

4.4 Bidders shall apportion each base Bid between various phases of the work, where stipulated in the Bid Form.

4.5 Bids shall be presented in sealed envelopes, which shall be plainly marked “Bids for (indicate name of project from cover sheet)” and mailed or delivered to the building and room number specified in the Advertisement for Bids.

4.6 Each Bidder shall be responsible for actual delivery of their bid during business hours, and it shall not be sufficient to show that a Bid was mailed in time to be received before scheduled closing time for receipt of bids, nor shall it be sufficient to show that a Bid was somewhere in a university facility.

4.7 The Bidder’s price shall include all federal sales, excise, and similar taxes that may be lawfully assessed in connection with their performance of work and purchase of materials to be incorporated in the work. City and State taxes shall not be included as stated in the General Conditions of the Contract for Construction.

4.8 No Bidder shall stipulate in their Bid any conditions not contained in the Bid Form or Contract Documents. Inclusion of any additional conditions or taking exception to any terms may result in rejection of the Bid.

4.9 The Owner reserves the right to waive informalities in bids and to reject any or all bids.

5. Modification and Withdrawal of Bids

5.1 A Bidder may withdraw their Bid at any time before the scheduled closing time for receipt of bids. No Bidder may withdraw their Bid after the scheduled closing time for receipt of bids.

5.2 Only a written request for modification or correction of a previously submitted Bid, contained in a sealed envelope that is plainly marked "Modification of Bid on (name of project on cover sheet)," which is addressed in the same manner as a Bid and received by Owner before the scheduled closing time for receipt of bids, will be accepted and the Bid modified in accordance with such written request.

6. Signing of Bids

6.1 All bids shall be signed manually, by an individual authorized to sign on behalf of the Bidder. The title or office held by the person signing for the Bidder shall appear below the signature.

6.2 A Bid should contain the full and correct legal name of the Bidder. If the Bidder is an entity registered with the Missouri Secretary of State, the Bidder's name on the Bid form should appear as shown in the Secretary of State's records.

6.3 A Bid from a partnership or joint venture shall be signed in the name of the partnership or joint venture by at least one partner or joint venturer or by an Attorney-in-Fact. If signed by Attorney-in-Fact there should be attached to the Bid, a Power of Attorney evidencing authority to sign the Bid executed by all partners or joint venturers.

6.4 A Bid from a corporation shall be signed by an officer of the corporation.

6.5 A Bid from a limited liability company (LLC) shall be signed by a manager or a managing member of the LLC.

6.6 A Bid from an individual or sole proprietor shall be signed in the name of the individual by the individual or an Attorney-in-Fact. If signed by Attorney-in-Fact there should be attached to the Bid, a Power of Attorney evidencing authority to sign the Bid

executed by the individual.

7. Bid Security

7.1 Each Bid shall be accompanied by a Bid Bond, certified check, or cashier's check, acceptable to and payable without condition to "The Curators of the University of Missouri" in an amount at least equal to five percent (5%) of the Bidder's Bid including additive alternates ("Bid Security").

7.2 Bid security is required as a guarantee that the Bidder will enter into a written contract and furnish a Performance Bond within the time and in form as specified herein or in the Contract Documents; and, if successful Bidder fails to do so, the Bid Security will be realized upon or retained by the Owner. The apparent low Bidder shall notify the Owner in writing within forty-eight (48) hours of the Bid opening of any circumstance that may affect the Bid Security including, but not limited to, an error in the Bid. This notification will not guarantee release of the Bidder's security and/or the Bidder from the Bidder's obligations.

7.3 If a Bid Bond is given as a Bid Security, the amount of the Bid Bond may be stated as an amount equal to at least five percent (5%) of the Bid, including additive alternates, described in the Bid. The Bid Bond shall be executed by the Bidder and a responsible surety licensed in the State of Missouri with a Best's rating of no less than A-/XL.

7.4 It is specifically understood that the Bid Security is a guarantee and shall not be considered as liquidated damages for failure of Bidder to execute and deliver the contract and Performance Bond, nor limit or fix the Bidder's liability to the Owner for any damages sustained because of failure to execute and deliver the required contract and Performance Bond.

7.5 The Bid Security of the two (2) lowest, responsive, responsible bidders will be retained by the Owner until a contract has been executed and an acceptable Performance Bond has been furnished, as required hereby, when such Bid Security will be returned. The Bid Bonds of all other Bidders will be destroyed and all other alternative forms of Bid Security will be returned to them within ten (10) days after the Owner has determined the two (2) lowest, responsive, responsible bids.

8. Bidder's Statement of Qualifications

8.1 Each Bidder shall present evidence of their experience, qualifications, financial responsibility, and ability to carry out the terms of the contract by completing and submitting with their Bid the "Bidder's Statement of Qualifications" form included with the Bid

documents.

8.2 Financial information required to be included with the Statement of Qualifications may be submitted by the Bidder in a separately sealed envelope, which will not be opened by the Owner during the public Bid opening.

8.3 The Bidder's Statement of Qualifications will be treated as confidential information by the Owner to the extent permitted by the Missouri Sunshine Law, Section 610.010, RSMo et seq.

8.4 Bids not accompanied by the Bidder's Statement of Qualifications may be rejected.

9. Award of Contract

9.1 The Owner reserves the right to let other contracts in connection with the work, including, but not limited to, contracts for furnishing and installation of furniture, equipment, machines, appliances, and other apparatus.

9.2 In awarding the contract, the Owner may take into consideration the ability of the Bidder, and their subcontractors, to handle promptly the additional work; the skill, facilities, capacity, experience, ability, responsibility, previous work, and financial standing of Bidder; the Bidder's ability to provide the required bonds and insurance; the quality, efficiency and construction of equipment proposed to be furnished; the period of time within which equipment is proposed to be furnished and delivered; success in achieving the specified Supplier Diversity Goals or demonstrating a good faith effort to do so as described in Article 15 of this document; and the Bidder's status as suspended or debarred. Inability of any Bidder to meet the requirements mentioned above may be cause for rejection of their Bid.

10. Contract Execution

10.1 The awarded Bidder shall submit within fifteen (15) days from receipt of notice of award, the documents required in Article 9 of the General Conditions of the Contract for Construction.

10.2 No bids will be considered binding upon the Owner until all such required documents have been furnished. Failure of Contractor to execute and submit such documents within the time specified will be treated, at the option of the Owner, as a breach of the Bidder's Bid Security and the Owner shall be under no further obligation to the Bidder.

11. Contract Security

11.1 When the Contract Sum exceeds \$50,000, the

Contractor shall procure and furnish a Performance Bond and a Payment Bond in the form prepared by the Owner. Each bond shall be in the amount equal to one hundred percent (100%) of the Contract Sum, as well as adjustments to the Contract Sum. The Performance Bond shall secure and guarantee the Contractor's faithful performance of the Contract, including but not limited to the Contractor's obligation to correct any defects after final payment has been made as required by the Contract Documents. The Payment Bond shall secure and guarantee payment of all persons performing labor on the Project under the Contract and furnishing materials in connection with the Contract in accordance with Section 107.170, RSMo. These bonds shall be in effect through the duration of the Contract plus any Guaranty Period required by the Contract Documents.

11.2 The bonds required hereunder shall be meet all requirements of Article 11 of the General Conditions of the Contract for Construction.

11.3 If the surety of any bond furnished by the Contractor is declared bankrupt or becomes insolvent or its right to conduct business in the State of Missouri is terminated, or it ceases to meet the requirements of this Article 11, the Contractor shall within ten (10) days substitute another bond and surety, both of which must be acceptable to the Owner. If the Contractor fails to make such substitution, the Owner may procure such required bonds on behalf of Contractor at Contractor's expense.

12. Time of Completion

12.1 The awarded Contractor shall agree to commence work within five (5) days of the date "Notice to Proceed" is received from the Owner, and the entire work shall be completed by the completion date specified or within the number of consecutive calendar days stated in the Special Conditions. The duration of the construction period, when specified in consecutive calendar days, shall begin when the contractor receives notice requesting the documents required in Article 9 of the General Conditions of the Contract for Construction.

13. Number of Contract Documents

13.1 The Owner will furnish the Contractor a copy of the executed contract, Performance Bond, and Payment Bond.

13.2 The Owner will furnish the Contractor the number of copies of complete sets of Drawings and Specifications for the work, as well as clarification and change order Drawings pertaining to change orders required during construction as set forth in the Special Conditions.

14. Missouri Products and Missouri Firms

14.1 The Curators of the University of Missouri have adopted a policy which is binding upon all employees and departments of the University of Missouri, and which by contract, shall be binding upon independent contractors and subcontractors with the University of Missouri whereby all other things being equal, and when the same can be secured without additional cost over foreign products, or products of other states, a preference shall be granted in all construction, repair and purchase contracts, to all products, commodities, materials, supplies, and articles mined, grown, produced, and manufactured in marketable quantity and quality in the State of Missouri, and to all firms, corporations or individuals doing business as Missouri firms, corporations, or individuals. Each Bidder submitting a Bid agrees to comply with and be bound by the foregoing policy.

15. Supplier Diversity

15.1 Award of Contract

15.1.1 The Bidder shall have a minimum goal of providing participation of Diverse Firms in the project, through self-performance, if a Diverse Firm, or by subcontracting with Diverse Firms as subcontractors, suppliers, or manufacturers, in the amount of the percent of contract price stated in the Bid Form ("Supplier Diversity Goals"). The Owner will take into consideration the Bidder's success in achieving the Supplier Diversity Goals in awarding the contract. Inability of any Bidder to meet one or more of the Supplier Diversity Goals may be cause for rejection of their Bid, unless the Bidder has demonstrated that they made a good faith effort to comply as set forth below.

15.1.2 In addition to the Supplier Diversity Goals set forth in the Bid Form, a three (3) point bonus preference will be given to a Bidder that is a certified Service-Disabled Veteran Enterprises (SDVE) business doing business as Missouri firm, corporation, or individual, or that maintains a Missouri office or place of business. The bonus preference will **not** be given to a Bidder for the use of SDVE subcontractors, suppliers, or manufacturers. The bonus preference shall be calculated and applied by reducing the Bid amount of the SDVE Bidder by three (3) percent of the apparent low, responsive Bidder's Bid. Based on this calculation, if the SDVE Bidder's resulting total Bid valuation is less than the Bid of the apparent low, responsive Bidder, the SDVE Bid becomes the apparent low, responsive Bid. This reduction is for evaluation purposes only and will have no impact on the actual amount(s) of the SDVE Bidder's Bid or the amount(s) of any contract awarded.

15.2 List of Diverse Firms

15.2.1 The Bidder shall submit, within forty-eight (48) hours of the receipt of bids to the University Contracting Officer, a list of Diverse Firms that will be performing as contractor, subcontractor, supplier, or manufacturer on the project. The list shall separately identify each Diverse Firm by name and address. If acceptance or non-acceptance of alternates will affect the designation of a subcontractor, supplier, or manufacturer, the Bidder shall provide information for each affected category.

15.2.2 Failure to include a complete list of Diverse Firms that will be used to meet the Supplier Diversity Goals may be grounds for rejection of the Bid.

15.2.3 The list of Diverse Firms shall be submitted in addition to any other listing of subcontractors required in the Bid Form or elsewhere in this document.

15.3 Supplier Diversity Goal Computation

15.3.1 The Bidder may count toward the Supplier Diversity Goal only expenditures to Diverse Firms that perform a commercially useful function in the work of a contract. A Diverse Firm is considered to perform a commercially useful function when it is responsible for executing a distinct element of the work or contract and is carrying out its responsibilities by actually performing managing and supervising the work.

15.3.2 The Bidder may count toward its Supplier Diversity Goals work granted to a second or subsequent tier subcontractor that is a Diverse Firm provided the Diverse Firm assumes the actual and contractual responsibility for performing work on the project. The Bidder may count toward its Supplier Diversity Goals expenditures for materials and/or supplies obtained from a Diverse Firm, provided the Diverse Firm assumes the actual and contractual responsibility for the provision of the materials and/or supplies. To perform a commercially useful function, a supplier or manufacturer that is a Diverse Firm must be responsible for negotiating price, determining quality and quantity, ordering the material, installing (where applicable) and paying for the material itself.

15.3.3 A Diverse Firm does not perform a commercially useful function if its role is solely that of an extra participant in a transaction, contract, or project through which funds are passed in order to obtain the appearance of participation. In determining whether a firm is such an extra participant, the Owner will examine similar transactions, particularly those in which Diverse Firms do not participate.

15.3.4 A Bidder that is a certified Diverse Firm may count one hundred percent 100% of the contract amount

towards the applicable Supplier Diversity Goal(s), less any amounts awarded to another Diverse Firm. For projects with separate Supplier Diversity Goals, the Bidder will be required to obtain participation in the other categories for which it is not certified through participation by subcontractors, suppliers, or manufacturers. Therefore, an MBE Bidder is expected to obtain the required SDVE and WBE/DBE/Veteran participation; a WBE/DBE/Veteran Bidder is expected to obtain the required MBE and SDVE participation; and a SDVE Bidder is expected to obtain the required MBE and WBE/DBE/Veteran participation.

15.3.5 If the Bidder is a joint venture and the joint venture itself is certified as a Diverse Firm, the joint venture may count toward the Supplier Diversity Goals that portion of the total dollar value of the work equal to the percentage of the ownership and control of the Diverse Firm participant in the joint venture. When a Diverse Firm performs work as a participant in a joint venture where the joint venture is **not** separately certified as a Diverse Firm, only the portion of the Contract Sum equal to the distinct, clearly defined portion of the work that the Diverse Firm performs with its own forces shall count toward the Supplier Diversity Goals.

15.3.6 If a Diverse Firm is certified in more than one Supplier Diversity category, that Diverse Firm may be used to satisfy more than one Supplier Diversity goal, provided that the Diverse Firm is awarded a sufficient percentage of the contract work to meet or exceed all applicable Supplier Diversity Goals.

15.4 Certification of Diverse Firms

15.4.1 The Bidder shall submit, within forty-eight (48) hours of the time for receipt of bids, to the University Contracting Officer, the information requested in the "Supplier Diversity Compliance Evaluation Form" for every Diverse Firm the Bidder intends to award work to under the contract to meet the Supplier Diversity Goals.

15.4.2 "Diverse Firm" is defined in Article 1 of the General Conditions of the Contract for Construction. The Bidder is responsible for obtaining information regarding the certification status of a Diverse Firm. A list of certified Diverse Firms may be obtained by contacting the agencies listed in the document entitled "Supplier Diversity Certifying Agencies."

15.4.3 Bidders are urged to encourage their prospective subcontractors, joint venture participants, team partners, suppliers and manufacturers who are Diverse Firms but are not currently certified to obtain certification from one of the approved agencies prior to

bidding.

15.5 Supplier Diversity Participation Waiver

15.5.1 The Bidder is required to make a good faith effort to locate and contract with Diverse Firms. If a Bidder has made a good faith effort to secure the required Supplier Diversity Participation and has failed, the Bidder shall submit within forty-eight (48) hours of the time for receipt of bids to the University Contracting Officer, the information requested in "Application for Supplier Diversity Participation Waiver." The Contracting Officer will review the Bidder's actions as set forth in the Bidder's "Application for Waiver" and any other factors deemed relevant by the Contracting Officer to determine if a good faith effort has been made to meet the Supplier Diversity Goal(s). If the Bidder is judged not to have made a good faith effort, the Bid may be rejected. Bidders who demonstrate that they have made a good faith effort to meet the Supplier Diversity Goal(s) may be awarded the contract regardless of the actual percent of Supplier Diversity Participation, provided that the Bid is otherwise acceptable and is determined to be the lowest, responsive, responsible Bid.

15.5.2 To determine the good faith effort of the Bidder, the Contracting Officer may evaluate factors including, but not limited to, the following:

15.5.2.1 The Bidder's attendance at pre-proposal meetings scheduled to inform Diverse Firms of contracting and subcontracting opportunities and responsibilities associated with Supplier Diversity Participation.

15.5.2.2 The Bidder's advertisements in general circulation trade association, and diverse (minority) focused media concerning subcontracting opportunities.

15.5.2.3 The Bidder's written notice to specific Diverse Firms that their services were being solicited in sufficient time to allow for their effective participation.

15.5.2.4 The Bidder's follow-up attempts to the initial solicitation(s) to determine with certainty whether Diverse Firms were interested.

15.5.2.5 The Bidder's efforts to divide the work into packages suitable for subcontracting to Diverse Firms.

15.5.2.6 The Bidder's efforts to provide interested Diverse Firms with sufficiently detailed information about the Drawings, Specifications and requirements of the contract, and clear scopes of work for the Diverse Firms to bid on.

15.5.2.7 The Bidder's efforts to solicit for specific sub-bids from Diverse Firms in good faith. Documentation should include names, addresses, and telephone numbers of Diverse Firms contacted, a description of all information provided to the Diverse Firms, and an explanation as to why agreements were not reached.

15.5.2.8 The Bidder's efforts to locate Diverse Firms not on the directory list and assist Diverse Firms in becoming certified as such.

15.5.2.9 The Bidder's initiatives to encourage and develop participation by Diverse Firms.

15.5.2.10 The Bidder's efforts to help Diverse Firms overcome legal or other barriers impeding the participation of Diverse Firms in the construction contract.

15.5.2.11 The availability of Diverse Firms and the adequacy of the Bidder's efforts to increase the participation of such business provided by the persons and organizations consulted by the Bidder.

15.6 Submittal of Forms

15.6.1 Within forty-eight (48) hours of the time for receipt of bids, the apparent low Bidder shall submit to the University Contracting Officer all Supplier Diversity Compliance Evaluation Form(s), and/or Application for Waiver with supporting information, and an "Affidavit of Supplier Diversity Participation" for every Diverse Firm the Bidder intends to award work on the contract. The affidavit will be signed by both the Bidder and the Diverse Firm. Failure to submit the documents in the time indicated may result in rejection of the Bid.

15.7 Additional Bid/Proposer Information

15.7.1 The Contracting Officer reserves the right to request from the apparent low Bidder additional information regarding the Bidder's proposed Supplier Diversity Participation and supporting documentation. The Bidder shall respond in writing to the Contracting Officer within twenty-four (24) hours of a request.

15.7.2 The Contracting Officer reserves the right to request additional information after the Bidder has responded to prior requests. This information may include follow up and/or clarification of the information previously submitted.

15.7.3 The Owner reserves the right to consider additional Supplier Diversity Participation submitted by the Bidder after bids are opened. The Owner may

elect to waive the good faith effort requirement if such additional participation achieves the Supplier Diversity Goal.

15.7.4 The Bidder shall provide to the Owner information related to the Supplier Diversity Participation included in the Bidder's proposal, including, but not limited to, the complete Application for Waiver, evidence of certification of participating Diverse firms, dollar amount of participation of Diverse Firms, information supporting a good faith effort as described above, and a list of all Diverse Firms that submitted bids to the Bidder with the Diverse Firm's price, and the name and the price of the firm awarded the scope of work.

16. List of Subcontractors

16.1 If a list of subcontractors is required on the Bid Form, the Bidder shall list the name, city, and state of the firm(s) that will accomplish that portion of the contract requested in the space provided. This list is separate from both the list of Diverse Firms required in Section 15.2 and the complete list of subcontractors required in Section 10.1 of this document. Should the Bidder choose to perform any of the listed portions of the work with its own forces, the Bidder shall enter its own name, city, and state in the space provided. If acceptance or non-acceptance of alternates will affect the designation of a subcontractor, the Bidder shall provide that information on the Bid Form.

16.2 Failure of the Bidder to supply the list of subcontractors required or the listing of more than one subcontractor for any category without designating the portion of the work to be performed by each, shall be grounds for the rejection of the Bid. The Bidder can petition the Owner to change a listed subcontractor within forty-eight (48) hours of the Bid opening. The Owner reserves the right to make the final determination on a petition to change a subcontractor. The Owner will consider factors such as clerical and mathematical errors in the Bid, a listed subcontractor's inability to perform the work, etc. Any request to change a listed subcontractor shall include at a minimum, a Bid sheet showing tabulation of the Bid; all subcontractor bids with documentation of the time they were received by the contractor; and a letter from the listed subcontractor on their letterhead stating why they cannot perform the work if applicable. The Owner reserves the right to ask for additional information.

16.3 Upon award of the contract, the requirements of Article 10 herein and Article 5 of the General Conditions of the Contract for Construction will apply.

University of Missouri

General Conditions

of the

Contract

for

Construction

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ARTICLE 1 GENERAL PROVISIONS

1.1 Basic Definitions

As used in the Contract Documents, the following terms shall have the meanings and refer to the parties designated in these definitions.

1.1.1 Owner

The Owner is The Curators of the University of Missouri. The Owner may act through its Board of Curators or any duly authorized committee or representative thereof. The Owner may also be referred to herein as "University".

1.1.2 Contracting Officer

The Contracting Officer is the duly authorized representative of the Owner with the authority to execute contracts. Communications to the Contracting Officer shall be forwarded via the Owner's Representative.

1.1.3 Owner's Representative

The Owner's Representative is authorized by the Owner as the administrator of the Contract and will represent the Owner during the progress of the Work. Communications from the Architect to the Contractor and from the Contractor to the Architect shall be through the Owner's Representative, unless otherwise indicated in the Contract Documents.

1.1.4 Architect

When the term "Architect" is used herein, it shall refer to the Architect or the Engineer specified and defined in the Contract for Construction or its duly authorized representative. Communications to the Architect shall be forwarded to the address shown in the Contract for Construction.

1.1.5 Owner's Authorized Agent

When the term "Owner's Authorized Agent" is used herein, it shall refer to an employee or agency acting on the behalf of the Owner's Representative to perform duties related to code inspections, testing, operational systems check, certification or accreditation inspections, or other specialized work.

1.1.6 Contractor

The Contractor is the person or entity with whom the Owner has entered into the Contract for Construction. The term "Contractor" means the Contractor or the Contractor's authorized representative.

1.1.7 Subcontractor and Lower-tier Subcontractor

A Subcontractor is a person or organization who has a contract with the Contractor to perform any of the Work. The term "Subcontractor" is referred to throughout the Contract Documents as if singular in number and means a Subcontractor or its authorized representative. The term "Subcontractor" also is applicable to those furnishing materials to be incorporated in the Work whether

performed at the Owner's site or off site, or both. A lower-tier Subcontractor is a person or organization who has a contract with a Subcontractor or another lower-tier Subcontractor to perform any of the Work at the site. Nothing contained in the Contract Documents shall create contractual relationships between the Owner or the Architect and any Subcontractor or lower-tier Subcontractor of any tier.

1.1.8 Diversity Definitions

"Diverse Firm" shall mean an approved, certified business concern which is at least fifty-one percent (51%) owned and controlled by one (1) or more diverse individuals as described below.

.1 Minority Business Enterprises (MBE)

Minority Business Enterprise (MBE) shall mean an approved certified business concern which is at least fifty-one percent (51%) owned and controlled by one (1) or more minorities as defined below or, in the case of any publicly-owned business, in which at least fifty-one percent (51%) of the stock of which is owned by one (1) or more minorities as defined below, and whose management and daily business operations are controlled by one (1) or more minorities as defined herein.

.1.1 "African Americans", which includes persons having origins in any of the black racial groups of Africa.

.1.2 "Hispanic Americans", which includes persons of Mexican, Puerto Rican, Cuban, Central or South American, or other Spanish culture or origin, regardless of race.

.1.3 "Native Americans", which includes persons of American Indian, Eskimo, Aleut, or Native Hawaiian origin.

.1.4 "Asian-Pacific Americans", which includes persons whose origins are from Japan, China, Taiwan, Korea, Vietnam, Laos, Cambodia, the Philippines, Samoa, Guam, the U.S. Trust Territories of the Pacific, or the Northern Marianas.

.1.5 "Asian-Indian Americans", which includes persons whose origins are from India, Pakistan, or Bangladesh.

.2 Women Business Enterprise (WBE)

Women Business Enterprise (WBE) shall mean an approved certified business concern which is at least fifty-one percent (51%) owned and controlled by one (1) or more women or, in the case of any publicly owned business, in which at least fifty-one percent (51%) of the stock of which is owned by one (1) or more women, and whose management and daily business operations are controlled by one (1) or more women.

.3 Veteran Owned Business

Veteran Owned Business shall mean an approved certified business concern which is at least fifty-one percent (51%) owned and controlled by one (1) or more Veterans or, in the case of any publicly owned business, in which at least fifty-one percent (51%) of the stock of which is owned by one (1) or more Veterans, and whose management and daily business operations are controlled by one (1) or more Veterans. Veterans must be certified by the appropriate federal agency responsible for veterans' affairs.

.4 Service-Disabled Veteran Enterprise (SDVE)

Service-Disabled Veteran Enterprise (SDVE) shall mean a business certified by the State of Missouri Office of Administration as a Service-Disabled Veteran Enterprise, which is at least fifty-one percent (51%) owned and controlled by one (1) or more Served-Disabled Veterans or, in the case

of any publicly-owned business, in which at least fifty-one percent (51%) of the stock of which is owned by one (1) or more Service-Disabled Veterans, and whose management and daily business operations are controlled by one (1) or more Serviced-Disabled Veterans.

.5 Disadvantaged Business Enterprise (DBE)

A Disadvantaged Business Enterprise (DBE) is a for-profit small business concern where a socially and economically disadvantaged individual owns at least 51% interest and also controls management and daily business operations. These firms can also be referred to as Small Disadvantaged Businesses (SDB). Eligibility requirements for certification are stated in 49 CFR (Code of Federal Regulations), part 26, Subpart D.

U.S. citizens that are African Americans, Hispanics, Native Americans, Asian-Pacific and Subcontinent Asian Americans, and women are presumed to be socially and economically disadvantaged. Also recognized as DBEs are Historically Black Colleges and Universities (HBCU) and small businesses located in Federal HUB Zones.

To be regarded as economically disadvantaged, an individual must have a personal net worth that does not exceed \$1.32 million. To be seen as a small business, a firm must meet Small Business Administration (SBA) size criteria (500 employees or less) and have average annual gross receipts not to exceed \$22.41 million. To be considered a DBE/SDB, a small business owned and controlled by socially and/or economically disadvantaged individuals must receive DBE certification from one of the recognized Missouri state agencies to be recognized in this classification.

1.1.9 Work

Work shall mean supervision, labor, equipment, tools, material, supplies, incidentals operations and activities required by the Contract Documents or reasonably inferable by the Contractor therefrom as necessary to produce the results intended by the Contract Documents in a safe, expeditious, orderly, and workmanlike manner, and in the best manner known to each respective trade.

1.1.10 Approved

The terms “approved”, “equal to”, “directed”, “required”, “ordered”, “designated”, “acceptable”, “compliant”, “satisfactory”, and similar words or phrases will be understood to have reference to action on the part of the Architect and/or the Owner’s Representative.

1.1.11 Contract Documents

The Contract Documents consist of (1) the executed Contract for Construction, (2) these General Conditions of the Contract for Construction, (3) any Supplemental Conditions or Special Conditions identified in the Contract for Construction, (4) the Specifications identified in the Contract for Construction, (5) the Drawings identified in the Contract for Construction, (6) Addenda issued prior to the receipt of bids, (7) Contractor’s bid addressed to Owner, including Contractor’s completed Qualification

Statement, (8) Contractor’s Performance Bond and Contractor’s Payment Bond, (9) Notice to Proceed, (10) and any other exhibits and/or post bid adjustments identified in the Contract for Construction, (11) Advertisement for Bid, (12) Information for Bidders, and (13) Change Orders issued after execution of the Contract. All other documents and technical reports and information are not Contract Documents, including without limitation, Shop Drawings, and Submittals.

1.1.12 Contract

The Contract Documents form the Contract and are the exclusive statement of agreement between the parties. The Contract represents the entire and integrated agreement between the parties hereto and supersedes prior representations or agreements, either written or oral. The Contract Documents shall not be construed to create a contractual relationship of any kind between the Owner and a Subcontractor or any lower-tier Subcontractor.

1.1.13 Change Order

The Contract may be amended or modified without invalidating the Contract only by a Change Order, subject to the limitations in Article 7 and elsewhere in the Contract Documents. A Change Order is a written instrument signed by the Owner and the Contractor stating their agreement to a change in the Work, the amount of the adjustment to the Contract Sum, if any, and the extent of the adjustment to the Contract Time, if any. Agreement to any Change Order shall constitute a final settlement of all matters relating to the change in the Work which is the subject of the Change Order, including, but not limited to, all direct and indirect costs associated with such change and any and all adjustments of the Contract Sum, time and schedule.

1.1.14 Substantial Completion

The terms “Substantial Completion” or “substantially complete” as used herein shall be construed to mean the completion of the entire Work, including all submittals required under the Contract Documents, except minor items which in the opinion of the Architect, and/or the Owner’s Representative will not interfere with the complete and satisfactory use of the facilities for the purposes intended.

1.1.15 Final Completion

The date when all punch list items are completed, including all closeout submittals and approval by the Architect is given to the Owner in writing.

1.1.16 Supplemental and Special Conditions

The terms “Supplemental Conditions” or “Special Conditions” shall mean the part of the Contract Documents which amend, supplement, delete from, or add to these General Conditions.

1.1.17 Day

The term “day” as used in the Contract Documents shall mean calendar day unless otherwise specifically defined.

1.1.18 Knowledge

The terms “knowledge,” “recognize” and “discover” their respective derivatives and similar terms in the Contract Documents, as used in reference to the Contractor, shall be interpreted to mean that which the Contractor knows or should know, recognizes, or should recognize and discovers or should discover in exercising the care, skill, and diligence of a diligent and prudent contractor familiar with the Work. Analogously, the expression “reasonably inferable” and similar terms in the Contract Documents shall be interpreted to mean reasonably inferable by a diligent and prudent contractor familiar with the Work.

1.1.19 Punch List

“Punch List” means the list of items, prepared in connection with the inspection(s) of the Project by the Owner’s Representative or the Architect in connection with Substantial Completion of the Work or a portion of the Work, which the Owner’s Representative or the Architect has designated as remaining to be performed, completed, or corrected before the Work will be accepted by the Owner.

1.1.20 Force Majeure

An event or circumstance that could not have been reasonably anticipated and is out of the control of both the Owner and the Contractor.

1.2 Specifications and Drawings

1.2.1 The Specifications are that portion of the Contract Documents consisting of the written requirements for materials, equipment, construction system, standards and workmanship and performance of related services for the Work identified in the Contract for Construction. Specifications are separated into titled divisions for convenience of reference only. Organization of the Specifications into divisions, sections and articles, and arrangement of Drawings shall not control the Contractor in dividing the Work among Subcontractors or in establishing the extent of Work to be performed by any trade. Such separation will not operate to make the Owner or the Architect an arbiter of labor disputes or work agreements.

1.2.2 The drawings herein referred to, consist of drawings prepared by the Architect, and are enumerated in the Contract Documents.

1.2.3 Drawings are intended to show general arrangements, design, and dimensions of work and are partly diagrammatic. Dimensions shall not be determined by scale or rule. If figured dimensions are lacking, they shall be supplied by the Architect on the Contractor’s written request to the Owner’s Representative.

1.2.4 The intent of the Contract Documents is to include all items necessary for the proper execution and completion of the Work by the Contractor. The Contract Documents are complimentary, and what is required by one shall be as binding as if required by all; performance by the Contractor

shall be required only to the extent consistent with the Contract Documents and reasonably inferable from them as being necessary to produce the intended results.

1.2.5 In the event of inconsistencies within or between parts of the Contract Documents, or between the Contract Documents and applicable standards, codes and ordinances, the Contractor shall (1) provide the better quality or greater quantity of Work or (2) comply with the more stringent requirement; either or both in accordance with the Owner’s Representative’s interpretation. On the Drawings, given dimensions shall take precedence over scaled measurements and large-scale drawings over small scale drawings. Before ordering any materials or doing any Work, the Contractor and each Subcontractor shall verify measurements at the Work site and shall be responsible for the correctness of such measurements. Any difference which may be found shall be submitted to the Owner’s Representative and the Architect for resolution before proceeding with the Work. If a minor change in the Work is found necessary due to actual field conditions, the Contractor shall submit detailed drawings of such departure for the approval by the Owner’s Representative and the Architect before making the change.

1.2.6 Data in the Contract Documents concerning lot size, ground elevations, present obstructions on or near the site, locations and depths of sewers, conduits, pipes, wires, etc., position of sidewalks, curbs, pavements, etc., and nature of ground and subsurface conditions have been obtained from sources the Architect believes reliable, but the Architect and the Owner do not represent or warrant that this information is accurate or complete. The Contractor shall verify such data to the extent possible through normal construction procedures, including but not limited to contacting utility owners and by prospecting.

1.2.7 Only work included in the Contract Documents is authorized, and the Contractor shall do no work other than that described therein.

1.2.8 Execution of the Contract by the Contractor is a representation that the Contractor has visited the site, become familiar with local conditions under which the Work is to be performed and correlated personal observations with requirements of the Contract Documents. The Contractor represents that it has performed its own investigation and examination of the Work site and its surroundings and satisfied itself before entering into this Contract as to:

- .1** conditions bearing upon transportation, disposal, handling, and storage of materials;
- .2** the availability of labor, materials, equipment, water, electrical power, utilities and roads;
- .3** uncertainties of weather, river stages, flooding and similar characteristics of the site;
- .4** conditions bearing upon security and protection of material, equipment, and Work in progress;
- .5** the form and nature of the Work site, including the surface and sub-surface conditions;

.6 the extent and nature of Work and materials necessary for the execution of the Work and the remedying of any defects therein; and

.7 the means of access to the site and the accommodations it may require and, in general, shall be deemed to have obtained all information as to risks, contingencies and other circumstances.

.8 the ability to complete work without disruption to normal campus activities, except as specifically allowed in the Contract Documents.

The Owner assumes no responsibility or liability for the physical condition or safety of the Work site, or any improvements located on the Work site. The Contractor shall be solely responsible for providing a safe place for the performance of the Work. The Owner shall not be required to make any adjustment in either the Contract Sum or Contract Time concerning any failure by the Contractor or any Subcontractor to comply with the requirements of this Paragraph.

1.2.9 Drawings, specifications, and copies thereof furnished by the Owner are and shall remain the Owner's property. They are not to be used on another project and, with the exception of one contract set for each party to the Contract, shall be returned to the Owner's Representative on request, at the completion of the Work.

1.3 Required Provisions Deemed Inserted

Each and every provision of law and clause required by law to be inserted in this Contract shall be deemed to be inserted herein, and the Contract shall be read and enforced as though it were included herein; and if through mistake or otherwise any such provision is not inserted, or is not correctly inserted, then upon the written application of either party the Contract shall forthwith be physically amended to make such insertion or correction.

ARTICLE 2 OWNER

2.1 Information and Services Required of Owner

2.1.1 Permits and fees are the responsibility of the Contractor under the Contract Documents, unless specifically stated in the Contract Documents that the Owner will secure and pay for specific necessary approvals, easements, assessments, and charges required for construction, use or occupancy of permanent structures, or for permanent changes in existing facilities.

2.1.2 When requested in writing by the Contractor, information or services under the Owner's control, which are reasonably necessary to perform the Work, will be furnished by the Owner with reasonable promptness to avoid delay in the orderly progress of the Work.

2.2 Owner's Right to Stop the Work

2.2.1 If the Contractor fails to correct Work which is not in strict accordance with the requirements of the Contract Documents or fails to carry out Work in strict accordance with the Contract Documents, the Owner's Representative may order the Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, the right of the Owner to stop the Work will not give rise to a duty on the part of the Owner to exercise this right for the benefit of the Contractor or any other person or entity. The Owner's lifting of Stop Work Order shall not prejudice the Owner's right to enforce any provision of this Contract.

2.3 Owner's Right to Carry Out the Work

2.3.1 If the Contractor defaults or neglects to carry out the Work in accordance with the Contract Documents and fails within a seven (7) day period after receipt of a written notice from the Owner to correct such default or neglect, the Owner may, without prejudice to other remedies the Owner may have, correct such default or neglect. In such case, an appropriate Change Order shall be issued deducting from payments then or thereafter due the Contractor the cost of correcting such deficiencies, including compensation for the Architect's additional services and expenses made necessary by such default or neglect. If payments then or thereafter due the Contractor are not sufficient to cover such amounts, the Contractor shall pay the difference to Owner. However, such notice shall be waived in the event of an emergency with the potential for property damage or the endangerment of students, faculty, staff, the public or construction personnel, at the sole discretion of the Owner.

2.3.2 In the event the Contractor has not satisfactorily completed all items on the Punch List within thirty (30) days of its receipt, the Owner reserves the right to complete the Punch List without further notice to the Contractor or its surety. In such case, the Owner shall be entitled to deduct from payments then or thereafter due the Contractor the cost of completing the Punch List items, including compensation for the Architect's additional services. If payments then or thereafter due Contractor are not sufficient to cover such amounts, the Contractor shall pay the difference to the Owner.

2.4 Extent of Owner Rights

2.4.1 The rights stated in Article 2 and elsewhere in the Contract Documents are cumulative and not in limitation of any rights of the Owner (1) granted in the Contract Documents, (2) at law or (3) in equity.

2.4.2 In no event shall the Owner have control over, charge of, or any responsibility for construction means, methods, techniques, sequences or procedures or for safety precautions and programs in connection with the Work, notwithstanding any of the rights and authority granted the Owner in the Contract Documents.

ARTICLE 3 CONTRACTOR

3.1 Contractor's Warranty

3.1.1 The Contractor warrants all equipment and materials furnished, and work performed, under this Contract, against defective materials and workmanship for a period of twelve months after acceptance as provided in this Contract, unless a longer period is specified, regardless of whether the same were furnished or performed by the Contractor or any Subcontractors of any tier. Upon written notice from the Owner of any breach of warranty during the applicable warranty period due to defective material or workmanship, the affected part or parts thereof shall be repaired or replaced by the Contractor at no cost to the Owner. Should the Contractor fail or refuse to make the necessary repairs, replacements, and tests when requested by the Owner, the Owner may perform, or cause the necessary work and tests to be performed, at the Contractor's expense, or exercise the Owner's rights under Article 14.

3.1.2 Should one or more defects mentioned above appear within the specified period, the Owner shall have the right to continue to use or operate the defective part or apparatus until the Contractor makes repairs or replacements or until such time as it can be taken out of service without loss or inconvenience to the Owner.

3.1.3 The above warranties are not intended as a limitation but are in addition to all other express warranties set forth in this Contract and such other warranties as are implied by law, custom, and usage of trade. The Contractor, and its surety or sureties, if any, shall be liable for the satisfaction and full performance of the warranties set forth herein.

3.1.4 Neither the final payment nor any provision in the Contract Documents nor partial or entire occupancy of the premises by the Owner, nor expiration of warranty stated herein, will constitute an acceptance of Work not done in accordance with the Contract Documents or relieve the Contractor of liability in respect to any responsibility for non-conforming work. The Contractor shall immediately remedy any defects in the Work and pay for any damage to other Work resulting therefrom upon written notice from the Owner. Should the Contractor fail or refuse to remedy the non-conforming work, the Owner may perform, or cause to be performed all actions necessary to bring the Work into conformance with the Contract Documents at the Contractor's expense.

3.1.5 The Contractor agrees to defend, indemnify, and save harmless The Curators of the University of Missouri, their officers, agents, employees, and volunteers, from and against all loss or expense from any injury or damages to property of others suffered or incurred on account of any breach of the aforesaid obligations and covenants. The Contractor agrees to investigate, handle, respond to and provide defense for and defend against any such liability, claims, and demands at the sole expense of the Contractor, or at the option of the University, agrees to pay to or

reimburse the University for the defense costs incurred by the University in connection with any such liability claims, or demands. The parties hereto understand and agree that the University is relying on and does not waive or intend to waive by any provision of this Contract, any monetary limitations or any other rights, immunities, and protections provided by the State of Missouri, as from time to time amended, or otherwise available to the University, or its officers, employees, agents or volunteers.

3.2 Compliance with Laws, Regulations, Permits, Codes, and Inspections

3.2.1 The Contractor shall, without additional expense to the Owner, comply with all applicable laws, ordinances, rules, permit requirements, codes, statutes, and regulations (which may be collectively referred to as "laws").

3.2.2 Since the Owner is an instrumentality of the State of Missouri, municipal, or political subdivision, ordinances, zoning ordinances, and other like ordinances are not applicable to construction on the Owner's property, and the Contractor will not be required to submit plans and specifications to any municipal or political subdivision authority to obtain construction permits or any other licenses or permits from or submit to, inspection by any municipality or political subdivision relating to the construction on the Owner's property, unless required by the Owner in these Contract Documents or otherwise in writing.

3.2.3 All fees, permits, inspections, or licenses required by municipality or political subdivision for operation on property not belonging to the Owner, shall be obtained by and paid for by the Contractor. The Contractor, of its own expense, is responsible to ensure that all inspections required by said permits or licenses on property, easements, or utilities not belonging to the Owner are conducted as required therein. All connection charges, assessments or transportation fees as may be imposed by any utility company or others are included in the Contract Sum and shall be the Contractor's responsibility.

3.2.4 If the Contractor has knowledge that any Contract Documents are at variance with any laws, including Americans with Disabilities Act – Standards for Accessible Design, ordinances, rules, regulations, or codes applying to the Work, Contractor shall promptly notify the Architect and the Owner's Representative, in writing, and any necessary changes will be adjusted as provided in the Contract Documents. However, it is not the Contractor's primary responsibility to ascertain that the Contract Documents are in accordance with applicable laws, unless such laws bear upon performance of the Work.

3.3 Anti-Kickback

3.3.1 No member or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this Contract or to any benefit that may arise therefrom, but this provision shall not be construed to extend to this Contract if made with a corporation for its general benefit.

3.3.2 No official of the Owner who is authorized in such capacity and on behalf of the Owner to negotiate, make, accept or approve, or to take part in negotiating, making, accepting, or approving any architectural, engineering, inspection, construction, or material supply contract or any Subcontract of any tier in connection with the construction of the Work shall have a financial interest in this Contract or in any part thereof, any material supply contract, Subcontract of any tier, insurance contract, or any other contract pertaining to the Work.

3.4 Supervision and Construction Procedures

3.4.1 The Contractor shall supervise and direct the Work, using the Contractor's best skill and attention. The Contractor shall be solely responsible for and have control over construction means, methods, techniques, sequences, and procedures and for coordinating all portions of the Work under the Contract. The Contractor shall supply sufficient and competent supervision and personnel, and sufficient material, plant, and equipment to prosecute the Work with diligence to ensure completion thereof within the time specified in the Contract Documents, and shall pay when due any laborer, Subcontractor of any tier, or supplier.

3.4.2 The Contractor, if an individual, shall give the Work an adequate amount of personal supervision, and if a partnership, corporation, or joint venture or other business entity, the Work shall be given an adequate amount of personal supervision by a partner or executive officer, as determined by the Owner's Representative.

3.4.3 The Contractor and each of its Subcontractors of any tier shall submit to the Owner such schedules of quantities and costs, progress schedules in accordance with 3.18 this document, payrolls, reports, estimates, records, and other data as the Owner may request concerning Work performed or to be performed under the Contract.

3.4.4 The Contractor shall be represented at the site by a competent superintendent from the beginning of the Work until its final acceptance, whenever Contract Work is being performed, unless otherwise permitted in writing by the Owner's Representative. The superintendent for the Contractor shall exercise general supervision over the Work and such superintendent shall have decision making authority of the Contractor. Communications given to the superintendent shall be binding as if given to the Contractor. The superintendent shall not be changed by the Contractor without approval from the Owner's Representative.

3.4.5 The Contractor shall establish and maintain a permanent benchmark to which access may be had during progress of the Work, and Contractor shall establish all lines and levels, and shall be responsible for the correctness of such. The Contractor shall be fully responsible for all layout work for the proper location of Work in strict accordance with the Contract Documents.

3.4.6 The Contractor shall establish and be responsible for wall and partition locations. If applicable, separate contractors shall be entitled to rely upon these locations and for setting their sleeves, openings, or chases.

3.4.7 The Contractor's scheduled outage/tie-in plan, time, and date for any utilities is subject to approval by the Owner's Representative. Communication with the appropriate entity and planning for any scheduled outage/tie-in of utilities shall be the responsibility of the Contractor. Failure of the Contractor to comply with the provisions of this Paragraph shall cause the Contractor to forfeit any right to an adjustment of the Contract Sum or Contract Time for any postponement, rescheduling or other delays ordered by the Owner in connection with such Work. The Contractor shall follow the following procedures for all utility outages/tie-ins or disruption of any building system:

- .1** All shutting of valves, switches, etc., shall be by the Owner's personnel.
- .2** The Contractor shall submit its preliminary outage/tie-in schedule with its baseline schedule.
- .3** The Contractor shall request an outage/tie-in meeting at least two weeks before the outage/tie-in is required.
- .4** The Owner's Representative will schedule an outage/tie-in meeting at least one week prior to the outage/tie-in.

3.4.8 The Contractor shall coordinate all Work so there shall be no prolonged interruption of existing utilities, systems, and equipment of the Owner. Any existing plumbing, heating, ventilating, air conditioning, or electrical disconnection necessary, which affect portions of this construction or building or any other building, must be scheduled with the Owner's Representative to avoid any disruption of operation within the building under construction or other buildings or utilities. In no case shall utilities be left disconnected at the end of a workday or over a weekend. Any interruption of utilities, either intentionally or accidentally, shall not relieve the Contractor from repairing and restoring the utility to normal service. Repairs and restoration shall be made before the workers responsible for the repair and restoration leave the job.

3.4.9 The Contractor shall be responsible for repair of damage to property on or off the project occurring during construction of project, and all such repairs shall be made to meet code requirements or to the satisfaction of the Owner's Representative if code is not applicable.

3.4.10 The Contractor shall be responsible for all shoring required to protect the Work or adjacent property and shall pay

for any damage caused by failure to shore or by improper shoring or by failure to give proper notice. Shoring shall be removed only after completion of permanent supports.

3.4.11 The Contractor shall maintain at the Contractor's own cost and expense, adequate, safe and sufficient walkways, platforms, scaffolds, ladders, hoists and all necessary, proper, and adequate equipment, apparatus, and appliances useful in carrying on the Work and which are necessary to make the place of Work safe and free from avoidable danger for students, faculty, staff, the public and construction personnel, and as may be required by safety provisions of applicable laws, ordinances, rules regulations and building and construction codes.

3.4.12 During the performance of the Work, the Contractor shall be responsible for providing and maintaining warning signs, lights, signal devices, barricades, guard rails, fences, and other devices appropriately located on site which shall give proper and understandable warning to all persons of danger of entry onto land, structure, or equipment, within the limits of the Contractor's work area.

3.4.13 The Contractor shall pump, bail, or otherwise keep any general excavations free of water. The Contractor shall keep all areas free of water before, during and after concrete placement. The Contractor shall be responsible for protection, including weather protection, and proper maintenance of all equipment and materials installed, or to be installed by the Contractor.

3.4.14 The Contractor shall be responsible for care of the Work and must protect same from damage of defacement until acceptance by the Owner. All damaged or defaced Work shall be repaired or replaced to the Owner's satisfaction, without cost to the Owner.

3.4.15 When requested by the Owner's Representative, the Contractor, at no extra charge, shall provide scaffolds or ladders in place as may be required by the Architect or the Owner for examination or inspection of Work in progress or completed.

3.4.16 The Contractor shall be responsible to the Owner for acts and omissions of the Contractor's employees, Subcontractors of any tier and their agents and employees, and any other entity or persons performing portions of the Work.

3.4.17 The Contractor shall not be relieved of its obligations to perform the Work in accordance with the Contract Documents either by activities or duties of the Owner's Representative or the Architect in their administration of the Contract, or by tests, inspections or approvals required or performed by persons other than the Contractor.

3.4.18 The Contractor shall be responsible for inspection of portions of the Work already performed under this Contract to determine that such portions are compliant and in proper condition to receive subsequent Work.

3.5 Use of Site

3.5.1 The Contractor shall limit operations and storage of material to the area within the Work limit lines shown on Drawings, except as necessary to connect to exiting utilities, shall not encroach on neighboring property, and shall exercise caution to prevent damage to existing structures.

3.5.2 Only materials and equipment, which are to be used directly in the Work, shall be brought to and stored on the Work site by the Contractor. After equipment is no longer required for the Work, it shall be promptly removed from the Work site. Protection of construction materials and equipment stored at the Work site from weather, theft, damage and all other adversity is solely the responsibility of the Contractor.

3.5.3 No project signs shall be erected without the written approval of the Owner's Representative.

3.5.4 The Contractor shall ensure that the Work is at all times performed in a manner that affords reasonable access, both vehicular and pedestrian, to the site of the Work and all adjacent areas. Particular attention shall be paid to access for emergency vehicles, including fire trucks. Wherever there is the possibility of interfering with normal emergency vehicle operations, the Contractor shall obtain permission from both campus and municipal emergency response entities prior to limiting any access. The Work shall be performed, to the fullest extent reasonably possible, in such a manner that public areas adjacent to the site of the Work shall be free from all debris, building materials and equipment likely to cause hazardous conditions. Without limitation of any other provision of the Contract Documents, the Contractor shall not interfere with the occupancy or beneficial use of (1) any areas and buildings adjacent to the site of the Work or (2) the Work in the event of partial occupancy. The Contractor shall assume full responsibility for any damage to the property comprising the Work or to the owner or occupant of any adjacent land or areas resulting from the performance of the Work.

3.5.5 The Contractor shall not permit any workers to use any existing facilities at the Work site, including, without limitation, lavatories, toilets, entrances, and parking areas other than those designated by Owner. The Contractor, Subcontractors of any tier, suppliers and employees shall comply with instructions or regulations of the Owner's Representative governing access to, operation of, and conduct while in or on the premises and shall perform all Work required under the Contract Documents in such a manner as not to unreasonably interrupt or interfere with the conduct of the Owner's operations. Any request for Work, a suspension of Work or any other request or directive received by the Contractor from occupants of existing buildings shall be referred to the Owner's Representative for determination.

3.5.6 The Contractor and the Subcontractor of any tier shall have its' name, acceptable abbreviation or recognizable logo and the name of the city and state of the mailing address of the principal office of the company, on each motor vehicle and motorized self-propelled piece of equipment which is used in connection with the project. The signs are required on such vehicles during the time the Contractor is working on the project.

3.6 Review of Contract Documents and Field Conditions by Contractor

3.6.1 The Contractor shall carefully study and compare the Contract Documents with each other and with information furnished by the Architect and the Owner and shall at once report in writing to the Architect and the Owner's Representative any errors, inconsistencies or omissions discovered. If the Contractor performs any construction activity which it knows or should have known involves a recognized error, inconsistency, or omission in the Contract Documents without such written notice to the Architect and the Owner's Representative, the Contractor shall assume appropriate responsibility for such performance and shall bear an appropriate amount of the attributable costs for correction.

3.6.2 The Contractor shall take field measurements and verify field conditions and shall carefully compare such field measurements and conditions and other information known to the Contractor with the Contract Documents before commencing activities. Errors, inconsistencies, or omissions discovered shall be reported in writing to the Architect and the Owner's Representative within twenty-four (24) hours. During the progress of the Work, the Contractor shall verify all field measurements prior to fabrication of building components or equipment and proceed with the fabrication to meet field conditions. The Contractor shall consult all Contract Documents to determine the exact location of all work and verify spatial relationships of all work. Any question concerning said location or spatial relationships shall be submitted to the Owner's Representative. Specific locations for equipment, pipelines, ductwork and other such items of work, where not dimensioned on plans, shall be determined in consultation with the Owner's Representative and the Architect. The Contractor shall be responsible for the proper fitting of the Work in place.

3.6.3 The Contractor shall provide, at the proper time, such material as required for support of the Work. If openings or chases are required, whether shown on Drawings or not, the Contractor shall see they are properly constructed. If required openings or chases are omitted, the Contractor shall cut them at the Contractor's own expense, but only as directed by the Architect, through the Owner's Representative.

3.6.4 Should the Contract Documents fail to particularly describe materials or goods to be used, it shall be the duty of the Contractor to inquire of the Architect and

the Owner's Representative what is to be used and to supply it at the Contractor's expense, or else thereafter replace it to the Owner's Representative's satisfaction. At a minimum, the Contractor shall provide the quality of materials as generally specified throughout the Contract Documents.

3.7 Cleaning and Removal

3.7.1 The Contractor shall keep the Work site and surrounding areas free from accumulation of waste materials, rubbish, debris, and dirt resulting from the Work and shall clean the Work site and surrounding areas as requested by the Architect and the Owner's Representative, including mowing of grass greater than six (6) inches high. The Contractor shall be responsible for the cost of clean up and removal of debris from premises. The building and premises shall be kept clean, safe, in a workmanlike manner, and in compliance with OSHA standards and code at all times. At completion of the Work, the Contractor shall remove from and about the Work site tools, construction equipment, machinery, fencing, and surplus materials. Further, at the completion of the Work, all dirt, stains, and smudges shall be removed from every part of the building, all glass in doors and windows shall be washed, and entire Work shall be left broom clean in a finished state ready for occupancy. The Contractor shall advise his Subcontractors of any tier of this provision, and the Contractor shall be fully responsible for leaving the premises in a finished state ready for use to the satisfaction of the Owner's Representative. If the Contractor fails to comply with the provisions of this Paragraph, the Owner may do so, and the cost thereof shall be charged to the Contractor.

3.8 Cutting and Patching

3.8.1 The Contractor shall be responsible for cutting, fitting, or patching required to complete the Work or to make its parts fit together properly.

3.8.2 The Contractor shall not damage or endanger a portion of the Work or fully or partially completed construction of the Owner or separate contractors by cutting, patching, or otherwise altering such construction, or by excavation. The Contractor shall not cut or otherwise alter such construction by the Owner or a separate contractor except with written consent of the Owner and of such separate contractor; such consent shall not be unreasonably withheld. The Contractor shall not unreasonably withhold from the Owner or a separate contractor the Contractor's consent to cutting or otherwise altering the Work.

3.8.3 If the Work involves renovation and/or alteration of existing improvements, the Contractor acknowledges that cutting and patching of the Work is essential for the Work to be successfully completed. The Contractor shall perform any cutting, altering, patching, and/or fitting of the Work necessary for the Work and the existing improvements to be fully integrated and to present the visual appearance of an entire, completed, and unified project. In performing any Work which requires cutting or patching, the Contractor shall use its best efforts to protect and preserve the visual appearance and

aesthetics of the Work to the reasonable satisfaction of both the Owner's Representative and the Architect.

3.9 Indemnification

3.9.1 To the fullest extent permitted by law, the Contractor shall defend, indemnify, and hold harmless the Owner, the Architect, the Architect's consultants, and the agents, employees, representatives, insurers and re-insurers of any of the foregoing (hereafter collectively referred to as the "Indemnitees") from and against claims, damages (including loss of use of the Work itself), punitive damages, penalties and civil fines unless expressly prohibited by law, losses and expenses, including, but not limited to, attorneys' fees, arising out of or resulting from performance of the Work to the extent caused in whole or in part by negligent acts or omissions or other fault of the Contractor, a Subcontractor of any tier, or anyone directly or indirectly employed by them or anyone for whose acts they may be liable, regardless of whether or not such claim, damage, loss, or expense is caused in part by the negligent acts or omissions or other fault of a party indemnified hereunder. The Contractor's obligations hereunder are in addition to and shall not be construed to negate, abridge, or reduce other rights or obligations of indemnity that the Owner may possess. If one or more of the Indemnitees demand performance by the Contractor of obligations under this Paragraph or other provisions of the Contract Documents and if the Contractor refuses to assume or perform, or delays in assuming or performing the Contractor's obligations, Contractor shall pay each Indemnitee who has made such demand its respective attorneys' fees, costs, and other expenses incurred in enforcing this provision. The defense and indemnity required herein shall be a binding obligation upon the Contractor whether or not an Indemnitee has made such demand. Even if a defense is successful to a claim or demand for which the Contractor is obligated to indemnify the Indemnitees from under this Paragraph, the Contractor shall remain liable for all costs of defense.

3.9.2 The indemnity obligations of the Contractor under this Section 3.9 shall survive termination of this Contract or final payment thereunder. In the event of any claim or demand made against any party which is entitled to be indemnified hereunder, the Owner may in its sole discretion reserve, return or apply any monies due or to become due the Contractor under the Contract for the purpose of resolving such claims; provided, however, that the Owner may release such funds if the Contractor provides the Owner with reasonable assurance of protection of the Owner's interests. The Owner shall in its sole discretion determine if such assurances are reasonable. The Owner reserves the right to control the defense and settlement of any claim, action or proceeding which the Contractor has an obligation to indemnify the Indemnitees against.

3.9.3 In claims against any person or entity indemnified under this Section 3.9 by an employee of the Contractor, a

Subcontractor of any tier, anyone directly or indirectly employed by them or anyone for whose acts they may be liable, the indemnification obligation under this Section 3.9 shall not be limited by a limitation on amount or type of damages, compensation or benefits payable by or for the Contractor or a Subcontractor of any tier under workers' or workmen's compensation acts, disability benefit acts or other employee benefit acts.

3.9.4 The obligations of the Contractor under Paragraph 3.9.1 shall not extend to the liability of the Architect, the Architect's agents or employees, arising out of the preparation and approval of maps, drawings, opinions, reports, surveys, Change Orders, designs, or Specifications.

3.10 Patents

3.10.1 The Contractor shall hold and save harmless the Owner and its officers, agents, servants, and employees from liability of any nature or kind, including cost and expense, for, or on account of, any patented or otherwise protected invention, process, article, or appliance manufactured or used in the performance of the Contract, including its use by the Owner, unless otherwise specifically stipulated in the Contract Documents.

3.10.2 If the Contractor uses any design, device, or material covered by letters patent or copyright, the Contractor shall provide for such use by suitable agreement with the Owner of such patented or copyrighted design, device, or material. It is mutually agreed and understood, without exception, that the Contract Sum include, and the Contractor shall pay all royalties, license fees or costs arising from the use of such design, device, or material in any way involved in the Work. The Contractor and/or sureties shall indemnify and save harmless the Owner from any and all claims for infringement by reason of the use of such patented or copyrighted design, device, or material or any trademark or copyright in connection with Work agreed to be performed under this Contract and shall indemnify the Owner for any cost, expense, or damage it may be obligated to pay by reason of such infringement at any time during the prosecution of the Work or after completion of the Work.

3.11 Delegated Design

3.11.1 If the Contract Documents specify the Contractor is responsible for the design of any Work as part of the project, then the Contractor shall procure all design services and certifications necessary to complete the Work as specified, from a design professional licensed in the State of Missouri. The signature and seal of that design professional shall appear on all drawings, calculations, specifications, certifications, Shop Drawings, and other submittals related to the Work. The design professional shall maintain insurance as required per Article 11.

3.12 Materials, Labor, and Workmanship

3.12.1 Materials and equipment incorporated into the Work shall strictly conform to the Contract Documents and representations and approved Samples provided by Contractor

and shall be of the most suitable grade of their respective kinds for their respective uses and shall be fit and sufficient for the purpose intended, merchantable, of good new material and workmanship, and free from defect. Workmanship shall be in accordance with the highest standard in the industry and free from defect in strict accordance with the Contract Documents.

3.12.2 Materials and fixtures shall be new and of latest design unless otherwise specified and shall provide the most efficient operating and maintenance costs to the Owner. All Work shall be performed by competent workers and shall be of best quality.

3.12.3 The Contractor shall carefully examine the Contract Documents and shall be responsible for the proper fitting of his material, equipment, and apparatus into the building.

3.12.4 The Contractor shall base its bid only on the Contract Documents.

3.12.5 Materials and workmanship shall be subject to inspection, examination, and testing by the Architect and the Owner's Representative at any and all times during manufacture, installation, and construction of any of them, at places where such manufacture, installation, or construction is performed.

3.12.6 The Contractor shall enforce strict discipline and good order among the Contractor's employees and other persons carrying out the Contract. The Contractor shall not permit employment of unfit persons or persons not skilled in tasks assigned to them.

3.12.7 Unless otherwise specifically noted, the Contractor shall provide and pay for supervision, labor, materials, equipment, tools, construction equipment and machinery, water, heat, utilities, transportation, and other facilities and services necessary for the proper execution and completion of the Work.

3.12.8 Substitutions

3.12.8.1 A substitution is a Contractor proposal of an alternate product or method in lieu of what has been specified or shown in the Contract Documents, which is not an "or equal" as set forth in Section 3.13.

3.12.8.2 The Contractor may make a proposal to the Architect and the Owner's Representative to use substitute products or methods as set forth herein, but the Architect's and the Owner's Representative's decision concerning acceptance of a substitute shall be final. The Contractor must do so in writing and setting forth the following:

.1 Full explanation of the proposed substitution and submittal of all supporting data including technical information, catalog cuts, warranties, test results, installation instructions, operating procedures, and other

like information necessary for a complete evaluation of the substitution.

.2 Reasons the substitution is advantageous and necessary, including the benefits to the Owner and the Work in the event the substitution is acceptable.

.3 The adjustment, if any, in the Contract Sum, in the event the substitution is acceptable.

.4 The adjustment, if any, in the time of completion of the Contract and the construction schedule in the event the substitution is acceptable.

.5 An affidavit stating that (a) the proposed substitution conforms to and meets all of the Contract Document requirements and is code compliant, except as specifically disclosed and set forth in the affidavit and (b) the Contractor accepts the warranty and correction obligations in connection with the proposed substitution as if originally specified by the Architect. Proposals for substitutions shall be submitted to the Architect and the Owner's Representative in sufficient time to allow the Architect and the Owner's Representative no less than ten (10) working days for review. No substitution will be considered or allowed without the Contractor's submittal of complete substantiating data and information as stated herein.

3.12.8.3 Substitutions may be rejected without explanation at the Owner's sole discretion and will be considered only under one or more of the following conditions:

.1 Required for compliance with interpretation of code requirements or insurance regulations then existing;

.2 Unavailability of specified products, through no fault of the Contractor;

.3 Material delivered fails to comply with the Contract Documents;

.4 Subsequent information discloses inability of specified products to perform properly or to fit in designated space;

.5 Manufacturer/fabricator refuses to certify or guarantee performance of specified product as required; or

.6 When in the judgment of the Owner or the Architect, a substitution would be substantially to the Owner's best interests, in terms of cost, time, or other considerations.

3.12.8.4 Whether or not any proposed substitution is accepted by the Owner or the Architect, the Contractor shall reimburse the Owner for any fees charged by the Architect or other consultants for evaluating each proposed substitution.

3.13 Approved Equal

3.13.1 Whenever in the Contract Documents any article, appliance, device, or material is designated by the name of a manufacturer, vendor, or by any proprietary or trade name, the words "or approved equal," shall automatically follow and shall be implied unless specifically indicated otherwise. The standard products of manufacturers other than those specified will be accepted when, prior to the ordering or use thereof, it is proven to the satisfaction of the Owner's Representative and the Architect they are equal in design, appearance, spare parts availability, strength, durability, usefulness, serviceability, operation cost, maintenance cost, and convenience for the purpose intended. Any general listings of approved

manufacturers in any Contract Document shall be for informational purposes only and it shall be the Contractor's sole responsibility to ensure that any proposed "or equal" complies with the requirements of the Contract Documents and is code compliant.

3.13.2 The Contractor shall submit to the Architect and the Owner's Representative a written and full description of the proposed "or equal" including all supporting data, including technical information, catalog cuts, warranties, test results, installation instructions, operating procedures, and similar information demonstrating that the proposed "or equal" strictly complies with the Contract Documents. The Architect or the Owner's Representative shall take appropriate action with respect to the submission of a proposed "or equal" item. If Contractor fails to submit proposed "or equals" as set forth herein, it shall waive any right to supply such items. The Contract Sum and Contract Time shall not be adjusted as a result of any failure by Contractor to submit proposed "or equals" as provided for herein. All documents submitted in connection with preparing an "or equal" shall be clearly and obviously marked as a proposed "or equal" submission.

3.13.3 No approvals or action taken by the Architect or Owner's Representative shall relieve the Contractor from its obligation to ensure that an "or equal" article, appliance, devise, or material strictly complies with the requirements of the Contract Documents. The Contractor shall not propose "or equal" items in connection with Shop Drawings or other Submittals, and the Contractor acknowledges and agrees that no approvals or action taken by the Architect or Owner's Representative with respect to Shop Drawings or other Submittals shall constitute approval of any "or equal" item or relieve the Contractor from its sole and exclusive responsibility. Any changes required in the details and dimensions indicated in the Contract Documents for the incorporation or installation of any "or equal" item supplied by the Contractor shall be properly made and approved by the Architect at the expense of the Contractor. No "or equal" items will be permitted for components of or extensions to existing systems when, in the opinion of the Architect, the named manufacturer must be provided in order to ensure compatibility with the existing systems, including, but not limited to, mechanical systems, electrical systems, fire alarms, smoke detectors, etc. No action will be taken by the Architect with respect to proposed "or equal" items prior to receipt of bids, unless otherwise noted in the Special Conditions.

3.14 Shop Drawings, Product Data, Samples, and Coordination Drawings/BIM Models

3.14.1 Shop Drawings are drawings, diagrams, schedules, and other data specifically prepared for the Work by the Contractor or a Subcontractor, sub-subcontractor, manufacturer, supplier, or distributor to illustrate some portion of the Work.

3.14.2 Product Data are illustrations, standard schedules, performance charts, instructions, brochures, diagrams, and other information furnished by the Contractor to illustrate materials or equipment for some portion of the Work.

3.14.3 Samples are physical samples which illustrate materials, equipment or workmanship and establish standards by which the Work will be judged.

3.14.4 Coordination Drawings are drawings for the integration of the Work, including work first shown in detail on Shop Drawings or product data. Coordination Drawings show sequencing and relationship of separate units of work which must interface in a restricted manner to fit in the space provided, or function as indicated. Coordination Drawings are the responsibility of the Contractor and are submitted for informational purposes. The Special Conditions will state whether Coordination Drawings are required. BIM models may be used for coordination in lieu of Coordination Drawings at the Contractor's discretion, unless required in the Special Conditions. The final Coordination Drawings/BIM Model will not change the Contract Documents, unless approved by a fully executed Change Order describing the specific modifications that are being made to the Contract Documents.

3.14.5 Shop Drawings, Coordination Drawings/BIM Models, Product Data, Samples, and similar submittals (collectively referred to as "Submittals") are not Contract Documents. The purpose of their submittal is to demonstrate for those portions of the Work for which submittals are required the way the Contractor proposes to conform to the information given and the design concept expressed in the Contract Documents.

3.14.6 The Contractor shall schedule submittal of Shop Drawings and Product Data to the Architect so that no delays will result in delivery of materials and equipment, advising the Architect of priority for checking of Shop Drawings and Product Data, but a minimum of two weeks shall be provided for this purpose. Because time is of the essence in this Contract, unless noted otherwise in the Special Conditions or Technical Specifications, all Submittals, Shop Drawings and Samples must be submitted as required to maintain the Contractor's plan for proceeding but must be submitted within ninety (90) days of the Notice to Proceed. If the Contractor believes that this milestone is unreasonable for any submittal, the Contractor shall request an extension of this milestone, within sixty (60) days of Notice to Proceed, for each submittal that cannot meet the milestone. The request shall contain a reasonable explanation as to why the ninety (90)-day milestone is unrealistic and shall specify a date on which the submittal will be provided, for approval by the Owner's Representative. Failure of the Contractor to comply with this Section may result in delays in the submittal approval process and/or charges for expediting approval, both of which will be the responsibility of the Contractor.

3.14.7 The Contractor, at its own expense, shall submit Samples required by the Contract Documents with reasonable promptness as to cause no delay in the Work or the activities of

separate contractors and no later than twenty (20) days before materials are required to be ordered for scheduled delivery to the Work site. Samples shall be labeled to designate material or products represented, grade, place of origin, name of producer, name of the Contractor and the name and number of the Owner's project. Quantities of Samples shall be twice the number required for testing so that the Architect can return one set of the Samples. Materials delivered before receipt of Architect's approval may be rejected by the Architect and in such event, the Contractor shall immediately remove all such materials from the Work site. When requested by the Architect or the Owner's Representative, Samples of finished masonry and field applied paints and finishes shall be located as directed and shall include sample panels built at the site of approximately twenty (20) square feet each.

3.14.8 The Contractor shall perform no portion of the Work requiring submittal and review of Shop Drawings, Product Data, Samples, or similar submittals until the respective submittal has been approved by the Architect. Such Work shall be in accordance with approved Submittals.

3.14.9 By approving and submitting Shop Drawings, Product Data, Samples and similar submittals, the Contractor represents such Submittals strictly comply with the requirements of the Contract Documents and that the Contractor has determined and verified field measurements and field construction criteria related thereto, that materials are fit for their intended use and that the fabrication, shipping, handling, storage, assembly and installation of all materials, systems and equipment are in accordance with best practices in the industry and are in strict compliance with any applicable requirements of the Contract Documents. The Contractor shall also coordinate each Submittal with other Submittals.

3.14.10 The Contractor shall be responsible for the correctness and accuracy of the dimensions, measurements and other information contained in the Submittals.

3.14.11 Each Submittal will bear a stamp or specific indication that the Submittal complies with the Contract Documents and the Contractor has satisfied its obligations under the Contract Documents with respect to the Contractor's review and approval of that Submittal. Each Submittal shall bear the signature of the representative of the Contractor who approved the Submittal, together with the Contractor's name, Owner's name, number of the Project, and the item name and specification section number.

3.14.12 The Contractor shall not be relieved of responsibility for deviations from requirements of the Contract Documents by the Architect's approval of Shop Drawings, Product Data, Samples, or similar submittals. The Contractor shall not be relieved of responsibility for errors or omissions in Shop Drawings, Product Data, Samples, or similar submittals by the Architect's approval thereof. Specifically, but not by way of limitation, the

Contractor acknowledges that the Architect's approval of Shop Drawings shall not relieve the Contractor for responsibility for errors and omissions in the Shop Drawings since the Contractor is responsible for the correctness of dimensions, details and the design of adequate connections and details contained in the Shop Drawings.

3.14.13 The Contractor shall direct specific attention, in writing or on resubmitted Shop Drawings, Product Data, Samples or similar submittals, to revisions other than those requested by the Architect on previous Submittals.

3.14.14 The Contractor represents and warrants that all Shop Drawings shall be prepared by persons and entities possessing expertise and experience in the trade for which the Shop Drawing is prepared and, if required by the Architect or applicable laws, by a licensed engineer or other design professional.

3.15 Record Drawings

3.15.1 The Contractor shall maintain a set of Record Drawings on site in good condition and shall use colored pencils to mark up said set with "record information" in a legible manner to show: (1) bidding addendums, (2) executed Change Orders, (3) deviations from the Drawings made during construction; (4) details in the Work not previously shown; (5) changes to existing conditions or existing conditions found to differ from those shown on any existing drawings; (6) the actual installed position of equipment, piping, conduits, light switches, electric fixtures, circuiting, ducts, dampers, access panels, control valves, drains, openings, and stub-outs; and (7) such other information as either the Owner or the Architect may reasonably request. The prints for Record Drawing use will be a set of "blue line" prints provided by the Architect to the Contractor at the start of construction. Upon Substantial Completion of the Work, the Contractor shall deliver all Record Drawings to the Owner and the Architect for approval. If not approved, the Contractor shall make the revisions requested by the Architect or the Owner's Representative. Final payment and any retainage shall not be due and owing to the Contractor until the final Record Drawings marked by the Contractor as required above are delivered to the Owner.

3.16 Operating Instructions and Service Manuals

3.16.1 The Contractor shall submit four (4) volumes of operating instructions and service manuals to the Architect before completing 50% of the adjusted contract amount. Payments beyond 50% of the adjusted contract amount may be withheld until all operating instructions and service manuals are received. The operating instructions and service manuals shall contain:

.1 Start-up and Shutdown Procedures: Provide a step-by-step write up of all major equipment. When manufacturer's printed start-up, trouble shooting and shut-down procedures are available, they may be incorporated into the operating manual for reference.

.2 Operating Instructions: Written operating instructions shall be included for the efficient and safe operation of all equipment.

.3 Equipment List: List of all major equipment as installed shall include model number, capacities, flow rate, and name-plate data.

.4 Service Instructions: The Contractor shall be required to provide the following information for all pieces of equipment.

.4.1 Recommended spare parts including catalog number and name of local suppliers or factory representative.

.4.2 Belt sizes, types, and lengths.

.4.3 Wiring diagrams.

.5 Manufacturer's Certificate of Warranty: Manufacturer's certificates of warranty shall be obtained for all major equipment. Warranty shall be obtained for at least one year from the date of Substantial Completion. Where longer period is required by the Contract Documents, the longer period shall govern.

.6 Parts catalogs: For each piece of equipment furnished, a parts catalog or similar document shall be provided which identifies the components by number for replacement ordering.

3.16.2 Submission

.1 Manuals shall be bound into volumes of standard 8 1/2" x 11" hard binders. Large drawings too bulky to be folded into 8 1/2" x 11" shall be separately bound or folded and in brown envelopes, cross-referenced and indexed with the manuals.

.2 The manuals shall identify the Owner's project name, project number, and include the name and address of the Contractor and major Subcontractors of any tier who were involved with the activity described in that particular manual.

3.17 Taxes

3.17.1 The Contractor shall pay all applicable sales, consumer, use, and similar taxes for the Work which are legally enacted when the bids are received, whether or not yet effective or scheduled to go into effect. However, certain purchases by the Contractor of materials incorporated in or consumed in the Work are exempt from certain sales tax pursuant to Section 144.062, RSMo. The Contractor shall be issued a Project Tax Exemption Certificate for this Work to obtain the benefits of Section 144.062, RSMo.

3.17.2 The Contractor shall furnish this certificate to all Subcontractors, and any person or entity purchasing materials for the Work shall present such certificate to all material suppliers as authorization to purchase, on behalf of the Owner, all tangible personal property and materials to be incorporated into or consumed in the Work and no other on a tax-exempt basis. Such suppliers shall provide to the purchasing party invoices bearing the name of the exempt entity and the project identification number. Nothing in this Section shall be deemed to exempt from any sales or similar tax the purchase of any construction machinery, equipment or tools used in construction, repairing or remodeling facilities for the Owner. All

invoices for all personal property and materials purchased under a Project Tax Exemption Certificate shall be retained by the Contractor for a period of five years and shall be subject to audit by the Director of Revenue.

3.17.3 Any excess resalable tangible personal property or materials which were purchased for the project under this Project Tax Exemption Certificate but which were not incorporated into or consumed in the Work shall either be returned to the supplier for credit or the appropriate sales or use tax on such excess property or materials shall be reported on a return and paid by such purchasing party not later than the due date of the purchasing party's Missouri sales or use tax return following the month in which it was determined that the materials were not used in the Work.

3.17.4 If it is determined that sales tax is owed by the Contractor on property and materials due to the failure of the Owner to revise the certificate expiration date to cover the applicable date of purchase, the Owner shall be liable for the tax owed.

3.17.5 The Owner shall not be responsible for any tax liability due to the Contractor's neglect to make timely orders, payments, etc. or the Contractor's misuse of the Project Tax Exemption Certificate. The Contractor represents that the Project Tax Exemption Certificate shall be used in accordance with Section 144.062, RSMo and the terms of the Project Tax Exemption Certificate. The Contractor shall indemnify the Owner for any loss or expense, including but not limited to, reasonable attorneys' fees, arising out of the Contractor's use of the Project Tax Exemption Certificate.

3.18 Contractor's Construction Schedules

3.18.1 The Contractor, within fifteen (15) days after the issuance of the Notice to Proceed, shall prepare and submit for the Owner's and the Architect's information the Contractor's construction schedule for the Work and shall set forth interim dates for completion of various components of the Work and Work Milestone Dates as defined herein. The schedule shall not exceed time limits current under the Contract Documents, shall be revised on a monthly basis or as requested by the Owner's Representative as required by the conditions of the Work, and shall provide for expeditious and practicable execution of the Work. The Contractor shall conform to the most recent schedule.

3.18.2 The construction schedule shall be in a detailed format satisfactory to the Owner's Representative and the Architect and in accordance with the detailed schedule requirements set forth in this document and the Special Conditions. If the Owner's Representative or the Architect has a reasonable objection to the schedule submitted by Contractor, the construction schedule shall be promptly revised by the Contractor. The Contractor shall monitor the progress of the Work for conformance with the requirements of the construction schedule and shall promptly advise the Owner of any delays or potential delays.

3.18.3 As time is of the essence to this Contract, the University expects that the Contractor will take all necessary steps to ensure that the project construction schedule shall be prepared in accordance with the specific requirements of the Special Conditions to this Contract. At a minimum, the Contractor shall comply with the following:

- .1** The schedule shall be prepared using Primavera P3, Oracle P6, Microsoft Project or other software acceptable to the Owner's Representative.
- .2** The schedule shall be prepared and maintained in CPM format, in accordance with Construction CPM Scheduling, published by the Associated General Contractors of American (AGC).
- .3** Prior to submittal to the Owner's Representative for review, the Contractor shall obtain full buy-in to the schedule from all major Subcontractors, in writing if so, requested by Owner's Representative.
- .4** Schedule shall be updated, in accordance with Construction CPM Scheduling, published by the AGC, on a monthly basis at minimum, prior to, and submitted with, the monthly pay application or as requested by the Owner's Representative.
- .5** Along with the update the Contractor shall submit a narrative report addressing all changes, delays and impacts, including weather to the schedule during the last month, and explain how the end date has been impacted by same.
- .6** The submission of the updated schedule certifies that all delays and impacts that have occurred on or to the project during the previous month have been factored into the update and are fully integrated into the schedule and the projected completion date.

Failure to comply with any of these requirements will be considered a material breach of this Contract. See Special Conditions for detailed scheduling requirements.

3.18.4 In the event the Owner's Representative or the Architect determines that the performance of the Work, as of a Milestone Date, has not progressed or reached the level of completion required by the Contract Documents, the Owner shall have the right to order the Contractor to take corrective measures necessary to expedite the progress of construction, including, without limitation, (1) working additional shifts or overtime, (2) supplying additional manpower, equipment, facilities, (3) expediting delivery of materials, and (4) other similar measures (hereinafter referred to collectively as "Extraordinary Measures"). Such Extraordinary Measures shall continue until the progress of the Work complies with the stage of completion required by the Contract Documents. The Owner's right to require Extraordinary Measures is solely for the purpose of ensuring the Contractor's compliance with the construction schedule. The Contractor shall not be entitled to an adjustment in the Contract Sum concerning Extraordinary Measures required by the Owner under or pursuant to this Paragraph. The Owner may exercise the rights furnished the Owner under or pursuant to this Paragraph as frequently as the Owner deems necessary to ensure that the Contractor's performance of the Work will

comply with any Milestone Date or completion date set forth in the Contract Documents.

ARTICLE 4 ADMINISTRATION OF THE CONTRACT

4.1 Rights of the Owner

4.1.1 The Owner's Representative will administer the Construction Contract. The Architect will assist the Owner's Representative with the administration of the Contract as indicated in these Contract Documents.

4.1.2 If, in the judgment of the Owner's Representative, it becomes necessary to accelerate the Work, the Contractor, when directed by the Owner's Representative in writing, shall cease work at any point and transfer its workers to such point or points and execute such portions of the Work as may be required to enable others to hasten and properly engage and carry out the Work, all as directed by the Owner's Representative. The additional cost of accelerating the Work, if any, will be borne by the Owner, unless the Contractor's work progress is behind schedule as shown on the most recent progress schedule.

4.1.3 If the Contractor refuses, for any reason, to proceed with what the Owner believes to be Contract Work, the Owner may issue a Construction Directive, directing the Contractor to proceed. The Contractor shall be obligated to promptly proceed with such work. If the Contractor feels that it is entitled to additional compensation as a result of a Construction Directive, it may file a claim for additional compensation and/or time, in accordance with 4.4 of this Contract.

4.1.4 The Owner's Representative, may, by written notice, require the Contractor to remove from involvement with the Work, any of the Contractor's personnel or the personnel of its Subcontractors of any tier whom the Owner's Representative may deem abusive, incompetent, careless, or a hindrance to proper and timely execution of the Work. The Contractor shall comply with such notice promptly, but without detriment to the Work or its progress.

4.1.5 The Owner's Representative will schedule Work status meetings that shall be attended by representatives of the Contractor and appropriate Subcontractors of any tier. Material suppliers shall attend status meetings if required by the Owner's Representative. These meetings shall include preconstruction meetings.

4.1.6 The Owner does not allow smoking on University property.

4.2 Rights of the Architect

4.2.1 The Architect will interpret requirements of the Contract Documents with respect to the quality, quantity, and other technical requirements of the Work itself within a reasonable time after written request of the Contractor. The

Contractor shall provide Owner's Representative a copy of such written request.

4.3 Review of the Work

4.3.1 The Architect, the Owner's Representative, and the Owner's Authorized Agent shall, at all times, have access to the Work; and the Contractor shall provide proper and safe facilities for such access.

4.3.2 The Owner's Representative shall have authority to reject Work that does not strictly comply with the requirements of the Contract Documents. Whenever the Owner's Representative considers it necessary or advisable for implementation of the intent of the Contract Documents, Owner's Representative shall have the authority to require additional inspection or testing of the Work, whether or not such Work is fabricated, installed, or completed.

4.3.3 The fact that the Architect or the Owner's Representative observed, or failed to observe, faulty Work, or Work done which is not in accordance with the Contract Documents, regardless of whether or not the Owner has released final payment, shall not relieve the Contractor from responsibility for all damages and additional costs of the Owner as a result of defective or faulty Work.

4.4 Claims

4.4.1 A Claim is a demand or assertion by the Contractor seeking, as a matter of right, adjustment or interpretation of Contract terms, payment of money, extension of time or any other relief with respect to the terms of the Contract. The term "Claim(s)" also includes demands and assertions of the Contractor arising out of or relating to the Contract Documents, including Claims based upon breach of contract, mistake, misrepresentation, or other cause for Contract Modification or rescission. Claims must be made by written notice. The Contractor shall have the responsibility to substantiate Claims.

4.4.2 Claims by the Contractor must be made promptly, and no later than within fourteen (14) days after occurrence of the event giving rise to such Claim. Claims must be made by written notice. Such notice shall include a detailed statement setting forth all reasons for the Claim and the amount of additional money and additional time claimed by the Contractor. The notice of Claims shall also strictly comply with all other provisions of the Contract Documents. The Contractor shall not be entitled to rely upon any grounds or basis for additional money or additional time not specifically set forth in the notice of Claim. All Claims not made in the manner provided herein shall be deemed waived and of no effect. The Contractor shall furnish the Owner and the Architect such timely written notice of any Claim provided for herein, including, without limitation, those in connection with alleged concealed or unknown conditions, and shall cooperate with the Owner and the Architect in any effort to mitigate the alleged or potential damages, delay or

other adverse consequences arising out of the condition which is the cause of such a Claim.

4.4.3 Pending final resolution of a Claim, the Contractor shall proceed diligently with performance of the Contract and the Owner shall continue to make payments that are not in dispute in accordance with the Contract Documents.

4.5 Claims for Concealed or Unknown Conditions

4.5.1 If conditions are encountered at the site which are (1) subsurface or otherwise concealed physical conditions which differ materially from those indicated in the Contract Documents, or (2) unknown physical conditions of an unusual nature, which differ materially from those ordinarily found to exist and generally recognized as inherent in construction activities of the character provided for in the Contract Documents, then notice by the Contractor shall be given to the Owner's Representative promptly before conditions are disturbed, and in no event later than three (3) days after first observance of the conditions. The Owner's Representative will promptly investigate such conditions. If such conditions differ materially, as provided for above and cause an increase or decrease in the Contractor's cost, or time, required for performance of the Work, an equitable adjustment in the Contract Sum or Contract Time, or both, shall be made, subject to the provisions and restrictions set for herein. If the Owner's Representative determines that the conditions at the site are not materially different from those indicated in the Contract Documents, and that no change in the terms of the Contract is justified, the Owner's Representative will so notify the Contractor in writing. If the Contractor disputes the finding of the Owner's Representative that no change in the terms of the Contract terms is justified, the Contractor shall proceed with the Work, taking whatever steps are necessary to overcome or correct such conditions so that Contractor can proceed in a timely manner. The Contractor may have the right to file a Claim in accordance with the Contract Documents.

4.5.2 It is expressly agreed that no adjustment in the Contract Time or Contract Sum shall be permitted, however, in connection with a concealed or unknown condition which does not differ materially from those conditions disclosed or which reasonably should have been disclosed by the Contractor's (1) prior inspections, tests, reviews and preconstruction investigations for the Project, or (2) inspections, tests, reviews and preconstruction inspections which the Contractor had the opportunity to make or should have performed in connection with the Project.

4.6 Claim for Additional Cost

4.6.1 If the Contractor makes a Claim for an increase in the Contract Sum, written notice as provided herein shall be given before proceeding to execute the Work. In addition to all other requirements for notice of a Claim, said notice shall detail and itemize the amount of all Claims and shall contain sufficient data to permit evaluation of same by the Owner.

4.7 Claims for Additional Time

4.7.1 If the Contractor makes a Claim for an increase in the

Contract Time, written notice as provided herein shall be given. In addition to other requirements for notice of a Claim, the Contractor shall include an estimate of the probable effect of delay upon the progress of the Work, utilizing a CPM Time Impact Schedule Analysis, (TIA) as defined in the AGC Scheduling Manual. In the case of a continuing delay, only one Claim is necessary.

.1 Time extensions will be considered for excusable delays only. That is, delays that are beyond the control and/or contractual responsibility of the Contractor.

4.7.2 If weather days are the basis for a Claim for additional time, such Claim shall be documented by the Contractor by data acceptable to the Owner's Representative substantiating that weather conditions for the period of time in question, had an adverse effect on the critical path of the scheduled construction. Weather days shall be defined as days on which critical path work cannot proceed due to weather conditions (including but not limited to rain, snow, etc.), in excess of the number of days shown on the anticipated weather day schedule in the Special Conditions. To be considered a weather day, at least four (4) working hours must be lost due to the weather conditions on a critical path scope item for that day. Weather days and anticipated weather days listed in the Special Conditions shall only apply to Monday through Friday. A weather day claim cannot be made for Saturdays, Sundays, New Year's Day, Martin Luther King Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, the day after Thanksgiving Day and Christmas Day, unless that specific day was approved in writing for work by the Owner's Representative.

.1 The Contractor must have fulfilled its contractual obligations with respect to temporary facilities and protection of its work, and worker protection for hot and cold weather per OSHA guidelines.

.2 If the contractual obligations have been satisfied, the Owner will review requests for non-compensable time extensions for critical path activities as follows:

.2.1 If the Contractor cannot work on a critical path activity due to adverse weather, after implementing all reasonable temporary weather protection, the Contractor will so notify the Owner's Representative. Each week, the Contractor will notify the Owner's Representative of the number of adverse weather days that it believes it has experienced in the previous week. As provided in the Contract, until such time as the weather days acknowledged by the Owner's Representative exceed the number of days of adverse weather contemplated in the Special Conditions, no request for extension of the Contract Time will be considered.

.2.2 If the Contractor has accumulated in excess of the number of adverse weather days contemplated in the Special Conditions due to the stoppage of work on critical path activities due to adverse weather, the Owner will consider a time extension request from the Contractor that is submitted in accordance with the Contract requirements. The Owner will provide a Change Order extending the time for contract completion or direct an acceleration of the

Work in accordance with the Contract terms and conditions to recover the time lost due to adverse weather in excess of the number of adverse weather working days contemplated in the Special Conditions.

4.7.3 A Force Majeure event or circumstance shall not be the basis of a claim by the Contractor seeking an adjustment in the Contract amount for costs or expenses of any type. With the exception of weather delays, which are administered under Article 4, and notwithstanding other requirements of the Contract, all Force Majeure events resulting in a delay to the critical path of the project shall be administered as provided in Article 8.

4.7.4 The Owner will consider and evaluate requests for time extensions due to changes or other events beyond the control of the Contractor on a monthly basis only, with the submission of the Contractor's updated schedule, in conjunction with the monthly application for payment.

4.8 Resolution of Claims and Disputes

4.8.1 The Owner's Representative will review Claims and take one or more of the following preliminary actions within ten days of receipt of a Claim: (1) request additional supporting data from the Contractor, (2) reject the Claim in whole or in part, (3) approve the Claim, or (4) suggest a compromise.

4.8.2 If a Claim has not been resolved, the Contractor shall, within ten (10) days after the Owner's Representative's preliminary response, take one or more of the following actions: (1) submit additional supporting data requested, (2) modify the initial Claim, or (3) notify the Owner's Representative that the initial Claim stands.

4.8.3 If a Claim has not been resolved after consideration of the foregoing and of further information presented by the Contractor, the Contractor has the right to seek administrative review as set forth in Section 4.9. However, Owner's Representative's decisions on matters relating to aesthetics will be final.

4.9 Administrative Review

4.9.1 Claims not resolved pursuant to the procedures set forth in the Contract Documents except with respect to Owner's Representative's decision on matters relating to aesthetic effect, and except for claims which have been waived by the making or acceptance of final payment, or the Contractor's acceptance of payments in full for changes in work may be submitted to administrative review as provided in this Section. All requests for administrative review shall be made in writing.

4.9.2 Upon written request from the Contractor, the Owner's Review Administrator authorized by the Campus Contracting Officer will convene a review meeting between the Contractor and Owner's Representative within fifteen (15) days of receipt of such written request. The Contractor and Owner's Representative will be allowed to present written

documentation with respect to the Claim(s) before or during the meeting. The Contractor and Owner's Representative will be allowed to present the testimony of any knowledgeable person regarding the Claim at the review meeting. The Owner's Review Administrator will issue a written summary of the review meeting and decision to resolve the Claim within fifteen (15) days. If the Contractor is in agreement with the decision the Contractor shall notify the Owner's Review Administrator in writing within five (5) days, and appropriate documentation will be signed by the parties to resolve the Claim.

4.9.3 If the Contractor is not in agreement with the proposal of the Owner's Review Administrator as to the resolution of the Claim, the Contractor may file a written appeal with the UM System Contracting Officer, [in care of the Executive Director of Facilities Planning and Development, University of Missouri, 130 General Services Building, University of Missouri, Columbia, Missouri 65211] within fifteen (15) days after receipt of the Owner's Review Administrator's proposal. The UM System Contracting Officer will call a meeting of the Contractor, the Owner's Representative, and the Owner's Review Administrator by written notice, within thirty (30) days after receipt of the Contractor's written appeal. The Owner's Review Administrator shall provide the UM System Contracting Officer with a copy of the written decision and summary of the review meeting, the Contractor's corrections, or comments regarding the summary of the review meeting, and any written documentation presented by the Contractor and the Owner's Representative at the initial review meeting. The parties may present further documentation and/or present the testimony of any knowledgeable person regarding the Claim at the meeting called by the UM System Contracting Officer.

4.9.4 The UM System Contracting Officer will issue a written decision to resolve the claim within fifteen (15) days after the meeting. If the Contractor is in agreement with the UM System Contracting Officer's proposal, the Contractor shall notify the UM System Contracting Officer in writing within five (5) days, and the Contractor and the Owner shall sign appropriate documents. The issuance of the UM System Contracting Officer's written proposal shall conclude the administrative review process even if the Contractor is not in agreement. However, proposals and any opinions expressed in such proposals issued under this Section will not be binding on the Contractor nor will the decisions or any opinions expressed be admissible in any legal actions arising from the Claim and will not be deemed to remove any right or remedy of the Contractor as may otherwise exist by virtue of Contract Documents or Law. The Contractor and the Owner agree that the Missouri Circuit Court for the County where the Work is located shall have exclusive jurisdiction to determine all issues between them. The Contractor agrees not to file any

complaint, petition, lawsuit or legal proceeding against the Owner except with such Missouri Circuit Court.

ARTICLE 5 SUBCONTRACTORS

5.1 Award of Subcontracts

5.1.1 Pursuant to Article 9, the Contractor shall furnish the Owner and the Architect, in writing, with the name, and trade for each Subcontractor and the names of all persons or entities proposed as manufacturers of products, materials and equipment identified in the Contract Documents and where applicable, the name of the installing contractor. The Owner's Representative will reply to the Contractor in writing if the Owner has reasonable objection to any such proposed person or entity. The Contractor shall not contract with a proposed person or entity to whom the Owner has made reasonable and timely objection.

5.1.2 The Contractor may request to change a Subcontractor. Any such request shall be made in writing to the Owner's Representative. The Contractor shall not change a Subcontractor, person, or entity previously disclosed if the Owner makes reasonable objection to such change.

5.1.3 The Contractor shall be responsible to the Owner for acts, defaults, and omissions of its Subcontractors of any tier.

5.2 Subcontractual Relations

5.2.1 By appropriate agreement, written where legally required for validity, the Contractor shall require each Subcontractor of any tier, to the extent of the Work to be performed by the Subcontractor of any tier, to be bound to the Contractor by terms of the Contract Documents and to assume toward the Contractor all the obligations and responsibilities which the Contractor, by these Documents, assumes toward the Owner and the Architect. Each subcontract agreement of any tier shall preserve and protect the rights of the Owner and the Architect under the Contract Documents with respect to the Work to be performed by the Subcontractor of any tier so that subcontracting thereof will not prejudice such rights and shall allow to the Subcontractor of any tier, unless specifically provided otherwise in the subcontract agreement, the benefit of all rights, remedies, and redress against the Contractor that the Contractor, by the Contract Documents, has against the Owner. Where appropriate, the Contractor shall require each Subcontractor to enter into similar agreements with its sub-subcontractors. The Contractor shall make available to each proposed Subcontractor of any tier, prior to the execution of the subcontract agreement, copies of the Contract Documents to which the Subcontractor of any tier shall be bound. Subcontractors of any tier shall similarly make copies of applicable portions of such documents available to their respective proposed Subcontractors of any tier.

5.2.2 All agreements between the Contractor and a Subcontractor or supplier shall contain provisions whereby Subcontractor or supplier waives all rights against the Owner,

Contractor, Owner's Representative, the Architect and all other Additional Insureds for all losses and damages caused by, arising out of, or resulting from any of the perils covered by property or builders risk insurance coverage required of the Contractor in the Contract Documents. If Contractor fails to include said provisions in all subcontracts, Contractor shall indemnify, defend and hold all the above entities harmless in the event of any legal action by Subcontractor or supplier. If insureds on any such policies require separate waiver forms to be signed by any Subcontractors of any tier or suppliers, Contractor shall obtain the same.

5.3 Contingent Assignment of Subcontract

5.3.1 No assignment by the Contractor of any amount or any part of the Contract or of the funds to be received thereunder will be recognized unless such assignment has had the written approval of the Owner, and the surety has been given due notice of such assignment and has furnished written consent hereto. In addition to the usual recitals in assignment Contracts, the following language must be set forth: "It is agreed that the funds to be paid to the assignee under this assignment are subject to performance by the Contractor of the Contract and to claims and to liens for services rendered or materials supplied for the performance of the Work called for in said Contract in favor of all persons, firms or corporations rendering such services or supplying such materials."

ARTICLE 6

SEPARATE CONTRACTS AND COOPERATION

6.1 The Owner reserves the right to let other contracts in connection with the Work.

6.2 It shall be the duty of each Contractor to whom Work may be awarded, as well as all Subcontractors of any tier employed by them, to communicate immediately with each other in order to schedule Work, locate storage facilities, etc., in a manner that will permit all Contractors to work in harmony in order that Work may be completed in the manner and within the time specified in the Contract Documents.

6.3 No Contractor shall delay another Contractor by neglecting to perform the Contractor's work at the proper time. Each Contractor shall be required to coordinate the Contractor's work with other Contractors to afford others reasonable opportunity for execution of their work. Any costs caused by defective, non-compliant, or ill-timed work, including actual damages and liquidated damages for delay, if applicable, shall be borne by the Contractor responsible therefor.

6.4 Each Contractor shall be responsible for damage to the Owner's or another Contractor's property done by the Contractor or the Contractor's employees, through his or their fault or negligence. If any Contractor shall cause

damage to any other Contractor, the Contractor causing such damage shall upon notice of any claim, settle with such Contractor.

6.5 The Contractor shall not claim from the Owner money damages or extra compensation under this Contract when delayed in initiating or completing his performance hereunder, when the delay is caused by labor disputes, acts of God, or the failure of any other Contractor to complete the Contractor's performance under any Contract with the Owner, where any such cause is beyond the Owner's reasonable control.

6.6 Progress schedule of the Contractor for the Work shall be submitted to other Contractors as necessary to permit coordinating their progress schedules.

6.7 If Contractors or Subcontractors of any tier refuse to cooperate with the instructions and reasonable requests of other contractors performing work for the Owner under separate contract, in the overall coordinating of the Work, the Owner's Representative may take such appropriate action and issue such instructions as in his judgement may be required to avoid unnecessary and unwarranted delay.

ARTICLE 7

CHANGES IN THE WORK

7.1 CHANGE ORDERS

7.1.1 A Change Order is a written instrument prepared by the Owner and signed by the Owner and the Contractor formalizing their agreement on the following:

- .1** a change in the Work
- .2** the amount of an adjustment, if any, in the Contract amount
- .3** an adjustment, if any, in the Contract Time

7.1.2 The Owner may at any time, order additions, deletions, or revisions in the Work by a Change Order or a Construction Change Directive. Such Change Order or Construction Change Directive shall not invalidate the Contract and requires no notice to the surety. Upon receipt of any such document, or written authorization from the Owner's Representative directing the Contractor to proceed pending receipt of the document, the Contractor shall promptly proceed with the Work involved in accordance with the terms set forth therein.

7.1.3 Until such time as the Change Order is formalized and signed by both the Owner and the Contractor it shall be considered a Change Order Request.

7.1.4 The amount of adjustment in the Contract price for authorized Change Orders will be agreed upon before such Change Orders becomes effective and will be determined as follows:

- .1** By a lump sum proposal from the Contractor and the Subcontractors of any tier, including overhead and profit.

.2 By a time and material basis with or without a specified maximum. The Contractor shall submit to the Owner's Representative itemized time and material sheets depicting labor, materials, equipment utilized in completing the Work on a daily basis for the Owner's Representative approval. If this pricing option is utilized, the Contractor may be required to submit weekly reports summarizing costs to date on time and material Change Order Requests not yet finalized.

.3 By unit prices contained in the Contractor's original bid and incorporated in the Construction Contract or subsequently agreed upon. Such unit prices contained in the Contractor's original proposal are understood to include the Contractor's overhead and profit. If unit prices are stated in the Contract Documents or subsequently agreed upon, and if quantities originally contemplated are so changed in a proposed Change Order that application of such unit prices to quantities of the Work proposed will cause substantial inequity to the Owner or to the Contractor, the applicable unit prices shall be equitably adjusted.

7.1.5 The Contractor shall submit all fully documented Change Order Requests with corresponding back-up documentation within the time requested by the Owner but no later than fourteen (14) working days following 1.) the Owner's request for pricing in the case of a lump sum; or 2.) the completion of unit price or time and material work.

7.1.6 The Contractor shall submit Change Order Requests in sufficient detail to allow evaluation by the Owner. Such requests shall be fully itemized by units of labor, material and equipment and overhead and profit. Such breakdowns shall be itemized as follows:

.1 Labor: The Contractor's proposal shall include breakdowns by labor, by trade, indicating number of hours and cost per hour for each Subcontractor as applicable. Such breakdowns shall only include employees in the direct employ of the Contractor or Subcontractors in the performance of the Work. Such employees shall only include laborers at the site, mechanics, craftsmen and foremen. Payroll cost shall include base rate salaries and wages plus the cost of fringe benefits required by agreement or custom and social security contributions, unemployment, payroll taxes and workers' or workmen's compensation insurance and other customary and legally required taxes paid by the Contractor or Subcontractors. Any item or expense outside of these categories is not allowed. The expense of performing Work after regular working hours, on Saturdays, Sundays or legal holidays shall not be included in the above, unless approved in writing and in advance by Owner.

.2 Material, supplies, consumables and equipment to be incorporated into the Work at actual invoice cost to the Contractor or Subcontractors; breakdowns showing all material, installed equipment and consumables fully itemized with number of units installed and cost per unit extended. Any singular item or items in aggregate greater than one thousand dollars (\$1,000) in cost shall be

supported with supplier invoices at the request of the Owner's Representative. Normal hand tools are not compensable.

.3 Equipment: Breakdown for required equipment shall itemize (at a minimum) delivery / pick-up charge, hourly rate and hours used. Operator hours and rate shall not be included in the equipment breakdown. Contractor must use the most cost-effective equipment available in the area and should not exceed the rates listed in the Rental Rate Blue Book for Construction Equipment (Blue Book). The Contractor shall submit documentation for the Blue Book to support the rate being requested.

7.2 Construction Change Directive

7.2.1 A construction change directive is a written order prepared and signed by the Owner, issued with supporting documents prepared by the Architect (if applicable), directing a change in the Work prior to agreement on adjustment of the Contract amount or Contract Time, or both. A Construction Change Directive shall be used in the absence of complete agreement between the Owner and Contractor on the terms of a Change Order. If the Construction Change Directive allows an adjustment of the Contract amount or time, such adjustment amount shall be based on one of the following methods:

.1 A lump sum agreement, properly itemized and supported by substantiating documents of sufficient detail to allow evaluation.

.2 By unit prices contained in the Contractor's original proposal and incorporated in the Construction Contract or subsequently agreed upon.

.3 A method agreed to by both the Owner and the Contractor with a mutually agreeable fee for overhead and profit.

.4 In the absence of an agreement between the Owner and the Contractor on the method of establishing an adjustment of the Contract amount, the Owner, with the assistance of the Architect, shall determine the adjustment amount on the basis of expenditures by the Contractor for labor, materials, equipment, and other costs consistent with other provisions of the Contract. The Contractor shall keep and submit to the Owner an itemized accounting of all cost components, either expended or saved, while performing the Work covered under the Construction Change Directive.

7.2.2 Upon receipt of a Construction Change Directive, the Contractor shall promptly proceed with the change in the Work involved and advise the Owner of the Contractor's agreement or disagreement with the method, if any, provided in the Construction Change Directive for determining the proposed adjustment in the Contract Sum, Contract Time, or both.

7.2.3 A Construction Change Directive signed by Contractor indicates the agreement of the Contractor therewith, including adjustment in Contract Sum and Contract Time or the method for determining them. Such agreement shall be effective immediately and shall be recorded as a Change Order.

7.3 Overhead and Profit

7.3.1 Overhead and Profit on Change Orders shall be applied as follows:

.1 The overhead and profit charged by the Contractor and Subcontractors shall be considered to include, but not limited to, job site office and clerical expense, normal hand tools, incidental job supervision, field supervision, payroll costs and other compensation for project manager, officers, executives, principals, general managers, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expeditors, time-keepers, and other personnel employed whether at the site or in principal or a branch office for general superintendent and administration of the Work.

.2 The percentages for overhead and profit charged on Change Orders shall be negotiated and may vary according to the nature, extent, and complexity of the Work involved but in no case shall exceed the following:

- 15% To the Contractor or the Subcontractor of any tier for Work performed with their respective forces or materials purchased
- 5% To the Contractor on Work performed by other than the Contractor's forces
- 5% To first tier Subcontractor on Work performed by his Subcontractor

.3 The Contractor will be allowed to add 2% for the cost of bonding and insurance to their cost of work. This 2% shall be allowed on the total cost of the added work, including overhead and profit.

.4 Not more than three mark-ups, not to exceed individual maximums shown above, shall be allowed regardless of the number of tier Subcontractors. Overhead and profit shall be shown separately for each Subcontractor of any tier and the Contractor.

.5 On proposals covering both increases and decreases in the amount of the Contract, the application of overhead and profit shall be on the net change in direct cost for the Contractor or Subcontractor of any tier performing the Work.

.6 The percentages for overhead and profit credit to the Owner on Change Orders that are strictly decreases in the quantity of work or materials shall be negotiated and may vary according to the nature, extent, and complexity of the Work involved, but shall not be less than the following:

Overhead and Profit

- 7.5% Credit to the Owner from the Contractor or Subcontractor of any tier for Work performed with their respective forces or materials purchased
- 2.5% Credit to the Owner from the Contractor on Work performed by other than his forces
- 2.5% Credit to the Owner from the first tier Subcontractor on Work performed by his Subcontractor of any tier

7.4 Extended General Conditions

7.4.1 The Contractor acknowledges that the percentage mark-up allowed on Change Orders for overhead and

profit cover the Contractor's cost of administering and executing the Work, inclusive of Change Orders that increase the Contract Time. The Contractor further acknowledges that no compensation beyond the specified mark-up percentages for extended overhead shall be due or payable as a result of an increase in the Contract Time.

7.4.2 The Owner may reimburse the Contractor for extended overhead if an extension of the Contract Time is granted by the Owner, in accordance with 4.7.1 and the Owner determines that the extension of the Contract Time creates an inequitable condition for the Contractor. If these conditions are determined by the Owner to exist, the Contractor may be reimbursed by unit prices contained in the Contractor's original bid and incorporated in the Construction Contract or by unit prices subsequently agreed upon.

7.4.3 If unit prices are subsequently agreed upon, the Contractor's compensation shall be limited as follows:

.1 For the portion of the direct payroll cost of the Contractor's project manager expended in completing the Work and the direct payroll cost of other onsite administrative staff not included in Article 7.3.1. Direct payroll cost shall include base rate salaries and wages plus the cost of fringe benefits required by agreement or custom and social security contributions, unemployment, payroll taxes and workers' or workmen's compensation insurance and other customary and legally required taxes paid by the Contractor;

.2 Cost of the Contractor's temporary office, including temporary office utilities expense;

.3 Cost of temporary utilities required in the performance of the Work;

.4 Profit not to exceed 5% of the total extended overhead direct costs;

7.4.4 All costs not falling into one of these categories and costs of the Contractor's staff not employed onsite are not allowed.

7.5 Emergency Work

7.5.1 If, during the course of the Work, the Owner has need to engage the Contractor in emergency work, whether related to the Work or not, the Contractor shall immediately proceed with the emergency work as directed by the Owner under the applicable provisions of the Contract. In so doing, the Contractor agrees that all provisions of the Contract remain in full force and effect and the schedule for the Work is not impacted in any way unless explicitly agreed to in writing by the Owner.

ARTICLE 8 TIME

8.1 Progress and Completion

8.1.1 The Contractor acknowledges and agrees that time is of the essence of this Contract.

8.1.2 The Contract Time is the period of time set forth in the Contract for Construction required for Substantial Completion and Final Completion of the entire Work or portions of the Work as defined in the Contract Documents. Time limits stated in the Contract Documents are of the essence of the Contract. The Contract Time may only be changed by a Change Order. By executing the Contract, the Contractor confirms that the Contract Time is a sufficient period for performing the Work in its entirety.

8.1.3 The Contractor shall not knowingly, except by agreement or instruction of the Owner in writing, prematurely commence operations on the site or elsewhere prior to the effective date of insurance and bonds required by Article 11 to be furnished by the Contractor.

8.1.4 The Contractor shall proceed expeditiously and diligently with adequate forces and shall achieve Substantial Completion and Final Completion within the time specified in the Contract Documents.

8.2 Delay in Completion

8.2.1 The Contractor shall be liable for all of the Owner's damages for delay in achieving Substantial Completion and/or Final Completion of the entire Work or portions of Work as set forth in the Contract Documents within the Contract Time unless liquidated damages are specifically provided for in the Contract Documents. If liquidated damages are specifically provided for in the Contract for Construction, the Contractor shall be liable for such liquidated damages as set forth in Section 8.3

8.2.2 All time limits stated in the Contract are of the essence of the Contract. However, if the Contractor is delayed at any time in the progress of the Work by any act or neglect of the Owner or by the Owner's Representative, by changes ordered in the Work, Force Majeure including but not limited to war, armed conflict, riot, civil commotion or disorder, act of terrorism or sabotage; epidemic, pandemic, outbreaks of infectious disease or any other public health crisis, including quarantine or other employee restrictions, compliance with any law or governmental order, rule, regulation or direction, curfew restriction, act of God or natural disaster such as earthquake, volcanic activity, landslide, tidal wave, tsunami, flood, damage or destruction by lightning, drought; explosion, fire, destruction of machines, equipment, prolonged break-down of transport, telecommunication or electric current; general labor disturbance such as but not limited to boycott, strike and lock-out, occupation of factories and premises, or any other causes beyond the Contractor's reasonable control which the Owner's Representative determines may justify delay then, upon submission of the Time Impact Schedule Analysis (TIA) justifying the delay called out in Section 4.7 of these General Conditions, the Contract Time may be extended for a reasonable time to the extent such delay will prevent the Contractor from achieving Substantial

Completion and/or Final Completion within the Contract Time and if performance of the Work is not, was not or would not have been delayed by any other cause for which the Contractor is not entitled to an extension of the Contract Time under the Contract Documents. It shall be a condition precedent to any adjustment of the Contract Time that the Contractor provides the Owner's Representative with written notice of the cause of delay within seven (7) days from the occurrence of the event or condition which caused the claimed delay. If a Force Majeure is approved by the Owner as the basis for a delay claim, an adjustment in the Contract Time to the extent the Force Majeure impacts the schedule is the only remedy. No increase in the Contract Sum for any reason shall be allowed due to a Force Majeure.

8.2.3 The Contractor further acknowledges and agrees that adjustments in the Contract Time will be permitted for a delay only to the extent such delay (1) is not caused, or could not have been anticipated, by the Contractor, (2) could not be limited or avoided by the Contractor's timely notice to the Owner of the delay, (3) prevents the Contractor from completing its Work by the Contract Time, and (4) is of a duration not less than one (1) day. Delays attributable to and within the control of a Subcontractor or supplier shall not justify an extension of the Contract Time.

8.2.4 Notwithstanding anything to the contrary in the Contract Documents, except as otherwise noted in these General Conditions, an extension in the Contract Time, to the extent permitted under this Article, shall be the sole remedy of the Contractor for any (1) delay in the commencement, prosecution or completion of the Work, (2) hindrance or obstruction in the performance of the Work, (3) loss of productivity, or (4) other claims due to or caused by any events beyond the control of both the Owner and the Contractor defined herein as Force Majeure. In no event shall the Contractor be entitled to any compensation or recovery of any damages or any portion of damages resulting from delays caused by or within the control of the Contractor or by acts or omissions of the Contractor or its Subcontractors of any tier or delays beyond the control of both the Owner and the Contractor. If the Contractor contends that delay, hindrance, obstruction or other adverse condition results from acts or omissions of the Owner, the Owner's Representative or the Architect, the Contractor shall provide written notice to the Owner within seven (7) calendar days of the event giving rise to such claim. The Contractor shall only be entitled to an adjustment in the Contract Sum to the extent that such acts or omissions continue after the Contractor's written notice to the Owner of such acts or omissions, but in no case shall Force Majeure be the basis of an increase in the Contract Sum. The Owner's exercise of any of its rights or remedies under the Contract Documents (including, without limitation, ordering changes in the Work, or directing suspension, rescheduling or correction of the Work) regardless of the extent or frequency of the Owner's exercise of such rights or remedies, shall not be the basis of any Claim for an increase in the Contract Sum or Contract Time. In the event Contractor is entitled to an adjustment in the Contract Sum for any delay, hindrance, obstruction or other adverse condition caused by the acts or

omissions of the Owner, the Owner's Representative or the Architect, the Contractor shall only be entitled to its actual direct costs caused thereby and the Contractor shall not be entitled to and waives any right to special, indirect, or consequential damages including loss of profits, loss of savings or revenues, loss of anticipated profits, labor inefficiencies, idle equipment, home office overhead, and similar type of damages.

8.2.5 If the Contractor submits a progress report or any construction schedule indicating, or otherwise expressing an intention to achieve completion of the Work prior to any completion date required by the Contract Documents or expiration of the Contract Time, no liability of the Owner to the Contractor for any failure of the Contractor to so complete the Work shall be created or implied. Further, the Contractor acknowledges and agrees that even if the Contractor intends or is able to complete the Work prior to the Contract Time, it shall assert no Claim and the Owner shall not be liable to the Contractor for any failure of the Contractor, regardless of the cause of the failure, to complete the Work prior to the Contract Time.

8.3 Liquidated Damages

8.3.1 If Liquidated Damages are prescribed on the Bid Form and Special Conditions in the Contract Documents, the Owner may deduct from the Contract Sum and retain as Liquidated Damages, and not as penalty or forfeiture, the sum stipulated in the Contract Documents for each calendar day after the date specified for completion of the Work that the entire Work is not substantially complete and/or finally complete.

8.3.2 The Owner's Representative shall establish the date of Substantial Completion and the date of Final Completion of the Work which shall be conclusive and binding on the Owner and the Contractor for the purpose of determining whether or not Liquidated Damages shall be assessed under terms hereof and the sum total amount due.

8.3.3 Liquidated Damages or any matter related thereto shall not relieve the Contractor or the Contractor's surety of any responsibility or obligation under this Contract.

ARTICLE 9 PAYMENTS AND COMPLETION

9.1 Commencement, Prosecution, and Completion

9.1.1 The Contractor shall commence Work within five (5) days upon the date of a "Notice to Proceed" from the Owner or the date fixed in the Notice to Proceed. The Contractor shall prosecute the Work with faithfulness and diligence, and the Contractor shall complete the Work within the Contract Time set forth in the Contract Documents.

9.1.2 The Owner will prepare and forward three (3) copies of the Contract and Performance Bond to the bidder to whom the Contract for the Work is awarded and such bidder shall return two (2) properly executed prescribed copies of the Contract and Bond to the Owner.

9.1.3 The construction period, when specified in consecutive calendar days, shall begin when the Contractor receives notice requesting the instruments listed in below. Before the Owner will issue Notice to Proceed to permit the Contractor to begin Work, the Owner shall have received the following instruments, properly executed as described in the Contract Documents. The documents below shall have been received by the Owner within fifteen (15) days after receipt of request for documents:

- .1** Contract
- .2** Bond (See Article 11)
- .3** Insurance (See Article 11)
- .4** List of Subcontractors of any tier
- .5** Affirmative Action Plan (See Article 13)

9.1.4 In the event the Contractor fails to provide the Owner such documents, the Contractor may not enter upon the site of the Work until such documents are provided. The date the Contractor is required to commence and complete the Work shall not be affected by the Owner denying the Contractor access to the site as a result of the Contractor's failure to provide such documents and the Contractor shall not be entitled to an adjustment of the Contract Time or Contract Sum as a result of its failure to provide the Owner the required documents

9.1.5 Contracts executed by partnerships shall be signed by all general partners of the partnership. Contracts signed by corporations shall be signed by the President or Vice President and the Secretary or Assistant Secretary. In case the Assistant Secretary or Vice President signs, it shall be so indicated by writing the word "Asst." or "Vice" in front of the words "Secretary" and "President". The corporate seal of the corporation shall be affixed. For all other types of entities, the Contractor and the person signing the Contract on behalf of the Contractor represent and warrant that the person signing the Contract has the legal authority to bind the Contractor to the Contract.

9.1.6 Any successful bidder which is a corporation organized in a state other than Missouri or any bidder doing business in the State of Missouri under a fictitious name shall furnish, at no cost to the Owner, no later than the time at which the executed Contract for Construction, the Payment Bond, and the Performance Bond are returned, a properly certified copy of its current Certificate of Authority and License to do business in the State of Missouri. No contract will be executed by the Owner until such certificate is furnished by the bidder, unless there already is on file with the Owner a current certificate, in which event, no additional certificate will be required during the period of time for which such current certificate remains in effect.

9.1.7 Within fifteen (15) calendar days of the issuance of a Notice to Proceed, the Contractor shall submit one (1) signed copy of the following instruments. No payment will be processed until all of these instruments are received and approved by the Owner's Representative.

- .1** Reproducible progress and payment schedule
- .2** Contractor's Schedule of Values
- .3** List of material suppliers
- .4** Itemized breakdown of all labor rates for each classification. Overhead and profit shall not be included. Payroll cost shall include base rate salaries and wages plus the cost of fringe benefits required by agreement or custom and social security contributions, unemployment, payroll taxes and workers' or workmen's compensation insurance and other customary and legally required taxes paid by the Contractor or Subcontractors. Any item or expense outside of these categories is not allowed. The expense of performing Work after regular working hours, on Saturdays, Sundays or legal holidays shall not be included in the above, unless approved in writing and in advance by the Owner.
- .5** Itemized breakdown of anticipated equipment rates (breakout operator rate). Overhead and profit shall not be included. Breakdown for required equipment shall itemize (at a minimum) delivery/ pick-up charge, hourly rate and hours used. Operator hours and rate shall not be included in the equipment breakdown. The Contractor must use the most cost-effective equipment available in the area and should not exceed the rates listed in the Rental Rate Blue Book for Construction Equipment (Blue Book). The Contractor shall submit documentation for the Blue Book to support the rate being requested.

9.1.8 The Contractor shall be paid electronically using the Owner's web-based payment program with a direct electronic transfer from the Owner's account into the Contractor's account. The Contractor must submit the following information to the Owner's Representative:

- .1** Bank Transit Number for the Contractor's bank into which the electronic deposit will be made.
- .2** Bank Account Number for the Contractor's account into which the electronic deposit will be made.
- .3** Contractor's E-Mail address so that formal notification of the deposit by the Owner can be provided.

9.2 Contract Sum

9.2.1 The Owner shall compensate the Contractor for all Work described herein, and in the Contract Documents the Contract Sum set forth in the Contract for Construction, subject to additions and deletions as provided hereunder.

9.3 Schedule of Values

9.3.1 Within fifteen (15) days after receipt of the Notice to Proceed, the Contractor shall submit to the Owner's Representative a schedule of values allocated to various portions of the Work, prepared in such form and supported by such data to substantiate its accuracy as the Owner's Representative may require. This schedule, unless objected

to by the Owner's Representative, shall be used as a basis for reviewing the Contractor's Applications for Payment. The values set forth in such schedule may, at the Owner's option be used in any manner as fixing a basis for additions to or deletions from the Contract Sum.

9.3.2 The progress and payment schedule of values shall show the following:

- .1** Enough detail as necessary to adequately evaluate the actual percent complete of any line item on a monthly basis, as determined by the Owner's Representative.
- .2** Line items, when being performed by a Subcontractor or material supplier, shall correlate directly back to the subcontract or purchase order amount if requested by the Owner's Representative.

9.4 Applications for Payment

9.4.1 The Contractor shall submit monthly to the Owner's Representative and the Architect an itemized Application for Payment for operations completed in accordance with the Schedule of Values. Such application shall be supported by such data substantiating the Contractor's right to payment as the Owner's Representative or the Architect may require, such as copies of requisitions from Subcontractors and material suppliers, and reflecting retainage as provided for herein.

9.4.2 Such applications shall not include requests for payment of amounts the Contractor does not intend to pay to a Subcontractor or material supplier

9.4.3 Progress payments shall be made on account of materials and equipment delivered to the site and incorporated in the Work. No payments will be made for materials and equipment stored at the Project site but not yet incorporated into the Work except as provided in Paragraph 9.4.4.

9.4.4 If approved in writing and in advance by the Owner, progress payments may be made on account of materials and equipment delivered and suitably stored at the site for subsequent incorporation in the Work. The Owner may in its sole discretion refuse to grant approval for payments for materials and equipment stored at the Project site but not yet incorporated in the Work. Any approval by the Owner for payment for materials and equipment delivered and suitably stored at the site, or stored offsite as noted below, for subsequent incorporation in the Work shall be conditioned upon Contractor's demonstrating that such materials and equipment are adequately protected from weather, damage, vandalism and theft and that such materials and equipment have been inventoried and stored in accordance with procedures established by or approved by the Owner. Nothing in this clause shall imply or create any liability on the part of the Owner for the Contractor's inventory and storage procedures or for any loss or damage to material, equipment or supplies stored on the site, whether incorporated into the Work or not. In the event any such loss or damage occurs, the Contractor remains solely responsible for all costs associated with replacement of the affected materials, supplies and equipment including labor and

incidental costs, and shall have no claim against the Owner for such loss.

No allowance shall be made in the project pay requests for materials not delivered to the site of the Work and incorporated into the Work, except as noted below. For the purposes of this Contract, offsite is defined as any location not owned or leased by the Owner. The Contractor shall submit a list of materials that they are requesting payment for offsite storage within sixty (60) days of Notice to Proceed.

.1 Items considered to be major items of considerable magnitude, if suitably stored, may be allowed in project pay requests on the basis of ninety percent (90%) of invoices

.2 Determination of acceptable "major items of considerable magnitude" and "suitably stored" shall be made by the Owner's Representative.

.3 Aggregate quantities of materials not considered unique to this project will not be considered for offsite storage payment.

.4 The Contractor shall submit to the Owner's Representative a list of the material for which application for payment for offsite storage is anticipated no less than forty-five days (45) prior to the submission of the applicable pay request. The list shall include a material description, applicable division, quantity, and discounts offered to the Owner for early payment. The Contractor shall also submit the location the material will be stored and the method of protection

.5 The storage facility shall be subject to approval by the Owner's representative, shall be located within an acceptable distance of the project sites as established by the Owner's Representative and all materials for the Owner's project must be stored separately from all other items within the storage facility and shall be labeled and stored in the name of "The Curators of the University of Missouri."

.6 The Owner's Representative shall be provided a minimum of two weeks' notice to visit the storage facility and inspect the stored material prior to submission of the pay request.

.7 Upon favorable inspection by the Owner's Representative, the Contractor shall, at the Owner's option, submit a Bill of Sale on forms provided by the Owner's Representative, transferring title of the material or equipment to "The Curators of the University of Missouri."

.8 An invoice provided by the supplier shall be included with the applicable pay request.

.9 The Contractor shall remain fully responsible for all items, until acceptance of the project by the Owner.

.10 The Contractor shall reimburse all costs incurred by the Owner in inspecting and verifying all material stored offsite, including mileage, airfare, meals, lodging and time, charged at a reasonable hourly rate.

.11 The Contractor shall furnish and maintain insurance covering the replacement cost of the material stored offsite against all losses and shall furnish proof of coverage with the application for payment for material stored offsite.

.12 The Contractor is responsible for all costs related to storage and handling of material stored offsite unless otherwise directed by the Owner's Representative.

9.4.5 The Application for Payment shall constitute a representation by the Contractor to the Owner that the Work has progressed to the point indicated; the quality of the Work covered by the Application for Payment is in accordance with the Contract Documents; and the Contractor is entitled to payment in the amount requested.

9.4.6 The Contractor will be reimbursed for ninety-five percent (95%) of the value of all labor furnished and material installed and computed in the same manner, less all previous payments made. On projects where a bond is not required, the Contractor will be reimbursed for ninety percent (90%) of the value of all labor furnished and material installed and computed in the same manner, less all previous payments made.

9.5 Approval for Payment

9.5.1 The Owner's Representative will, within fifteen (15) days after receipt of the Contractor's Application for Payment, either approve Contractor's Application for Payment for such amount as the Owner's Representative determines is properly due or notify the Contractor of the Owner's Representative's reasons for withholding certification in whole or in part as provided in Section 9.6.

9.6 Decisions to Withhold Approval

9.6.1 The Owner's Representative may decide not to certify payment and may withhold approval in whole or in part, to the extent reasonably necessary to protect the Owner. If the Owner's Representative is unable to approve payment in the amount of the Application, the Owner's Representative will notify the Contractor as provided in Paragraph 9.5.1. If the Contractor and Owner's Representative cannot agree on a revised amount, the Owner's Representative will promptly issue approval for payment for the amount for which the Owner's Representative is able to determine is due to the Contractor. The Owner's Representative may also decide not to approve payment or, because of subsequently discovered evidence or subsequent observations, may nullify the whole or a part of approval for payment previously issued, to such extent as may be necessary in the Owner's Representative opinion to protect the Owner from loss because of:

.1 defective or non-compliant Work not remedied, or damage to completed Work;

.2 failure to supply sufficient skilled workers or suitable materials;

.3 third party claims filed or reasonable evidence indicating probable filing of such claims;

.4 failure of the Contractor to make payments properly to Subcontractors or for labor, materials or equipment, the Owner may, at its sole option issue joint checks to Subcontractors who have presented evidence that it has not been paid in accordance with the Contract;

.5 reasonable evidence that the Work cannot be completed for the unpaid balance of the Contract Sum;

- .6 damage to the Owner or another contractor;
- .7 reasonable evidence that the Work will not be completed within the Contract Time or an unsatisfactory rate of progress made by the Contractor;
- .8 The Contractor's failure to comply with applicable laws;
- .9 The Contractor's or Subcontractor's failure to comply with applicable wage requirements; or
- .10 The Contractor's failure to carry out the Work in strict accordance with the Contract Documents.

9.6.2 When the above reasons for withholding approval are removed, approval will be made for amounts previously withheld.

9.7 Progress Payments

9.7.1 Based upon Applications for Payment submitted to the Owner by the Contractor and approvals issued by the Owner's Representative, the Owner shall make progress payments on account of the Contract Sum to the Contractor as provided below and elsewhere in the Contract Documents.

9.7.2 The period covered by each Application for Payment shall be one (1) calendar month.

9.7.3 The Owner shall make payment to the Contractor for amounts due and approved by the Owner's Representative not later than thirty (30) days after the Owner approves a properly detailed Application for Payment which is in compliance with the Contract Documents. The Owner shall not have the obligation to process or pay such Application for Payment until it receives an Application for Payment satisfying such requirements.

9.7.4 Based on the Schedule of Values submitted by the Contractor, Applications for Payment submitted by the Contractor shall indicate the actual percentage of completion of each portion of the Contractor's Work as of the end of the period covered by the Application for Payment.

9.7.5 The Contractor shall promptly pay each Subcontractor and supplier, upon receipt of payment from the Owner, out of the amount paid to the Contractor on account of such Subcontractor's or supplier's portion of the Work, the amount to which said Subcontractor or supplier is entitled, reflecting percentages actually retained from payments to the Contractor on account of each Subcontractor's or supplier's portion of the Work, in full compliance with state statute. The Contractor shall, by appropriate agreement with each Subcontractor or supplier, require each Subcontractor or supplier to make payments to Sub-subcontractors in similar manner.

9.7.6 Neither the Owner nor the Architect shall have an obligation to pay or to see to the payment of money to a Subcontractor of any tier nor a laborer or employee of the Contractor except to the extent required by law. Retainage provided for by the Contract Documents are to be retained

and held for the sole protection of the Owner, and no other person, firm or corporation shall have any claim or right whatsoever thereto.

9.7.7 An approval for payment by the Owner's Representative, a progress payment, or partial or entire use or occupancy of the Project by the Owner shall not constitute acceptance of Work not in accordance with the Contract Documents.

9.8 Failure of Payment

9.8.1 If the Owner is entitled to reimbursement or payment from the Contractor under or pursuant to the Contract Documents, such payment by the Contractor shall be made promptly upon demand by the Owner. Notwithstanding anything contained in the Contract Documents to the contrary, if the Contractor fails to promptly make any payment due the Owner, or the Owner incurs any costs and expenses to cure any default of the Contractor or to correct defective Work, the Owner shall have an absolute right to offset such amount against the Contract Sum and may, in the Owner's sole discretion, elect either to: (1) deduct an amount equal to that to which the Owner is entitled from any payment then or thereafter due the Contractor from the Owner, or (2) issue a written notice to the Contractor reducing the Contract Sum by an amount equal to that to which the Owner is entitled.

9.9 Substantial Completion

9.9.1 Substantial Completion is the stage in the progress of the Work as defined in Paragraph 1.1.14 as certified by the Owner.

9.9.2 When the Contractor considers the Work, or a portion thereof which the Owner agrees to accept separately, is substantially complete, the Contractor shall notify the Owner and the Architect. The Owner's Representative will make an inspection to determine whether the Work or designated portion thereof is substantially complete. If the Owner's Representative's inspection discloses any item which is not in accordance with the requirements of the Contract Documents, the Contractor shall complete or correct such item upon notification by the Owner's Representative. The Contractor shall then submit a request for another inspection by the Owner's Representative to determine Substantial Completion. When the Work or designated portion thereof is substantially complete, the Owner will issue a Certificate of Substantial Completion. Substantial Completion shall transfer from the Contractor to the Owner responsibilities for security, maintenance, heat, utilities, damage to the Work and insurance. In no event shall the Contractor have more than thirty (30) days to complete all items on the Punch List and achieve Final Completion. Warranties required by the Contract Documents shall commence on the date of Substantial Completion or as agreed otherwise.

9.9.3 At the date of Substantial Completion, the Contractor may apply for, and if approved by Owner's Representative, the Owner, subject to the provisions herein, shall increase total payments to one hundred percent (100%) of the Contract Sum

less one hundred fifty percent (150%) of the value of any incomplete Work and unsettled claims, as determined by the Owner's Representative.

9.10 Partial Occupancy or Use

9.10.1 The Owner may occupy or use any completed or partially completed portion of the Work at any stage when such portion is designated by separate agreement with the Contractor. Such partial occupancy or use may commence whether or not the portion is substantially complete, provided the Owner and the Contractor have accepted in writing the responsibilities assigned to each of them for payments, retainage, security, maintenance, heat, utilities, damage to the Work and insurance. Consent of the Contractor to partial occupancy or use shall not be unreasonably withheld. The stage of the progress of the Work shall be determined by the Owner's Representative.

9.10.2 Immediately before such partial occupancy or use, the Owner, and the Contractor shall jointly inspect the area to be occupied or portion of the Work to be used in order to determine and record the condition of the Work. Unless otherwise agreed upon, partial occupancy or use of a portion or portions of the Work shall not constitute acceptance of Work not complying with the requirements of the Contract Documents.

9.11 Final Completion and Final Payment

9.11.1 Upon receipt of written notice that the Work is ready for final inspection and acceptance and upon receipt of a final Application for Payment, the Owner's Representative and the Architect will promptly make such inspection and, when the Owner's Representative and the Architect find the Work acceptable under the Contract Documents and the Contract fully performed, the Owner's Representative will promptly issue a final approval for payment; otherwise, the Owner's Representative will return the Contractor's Final Application for Payment to the Contractor, indicating in writing the reasons for refusing to recommend final payment, in which case Contractor shall make the necessary corrections and resubmit the Application. Submission of a Final Application for Payment shall constitute a further representation that conditions listed in Paragraph 9.11.2 as precedent to the Contractor being entitled to final payment have been fulfilled. All warranties and guarantees required under or pursuant to the Contract Documents shall be assembled and delivered by the Contractor to the Owner's Representative as part of the final Application for Payment. The final approval for payment will not be issued by the Owner's Representative until all warranties and guarantees have been received and accepted by the Owner.

9.11.2 The Owner will request the Contractor to submit the application for final payment along with a manually signed notarized letter on the Contractor's letterhead certifying that:

.1 Labor costs, prevailing wage rates, fringe benefits and material costs have been paid.

.2 Subcontractors of any tier and manufacturers furnishing materials and labor for the project have fully completed their Work and have been paid in full.

.3 The project has been fully completed in accordance with the Contract Documents as modified by Change Orders.

.4 The acceptance by the Contractor of its final payment, by check or electronic transfer, shall be and operate as a release of all claims of the Contractor against the Owner for all things done or furnished or relating to the Work and for every act or alleged neglect of the Owner arising out of the Work.

9.11.3 Final payment constituting the entire unpaid balance due shall be paid by the Owner to the Contractor within thirty (30) days after the Owner's receipt of Contractor's Final Application for Payment which satisfies all the requirements of the Contract Documents and the Owner's receipt of all information and documents set forth in Section 9.11.

9.11.4 No payment under this Contract, including but not limited to final payment, shall constitute acceptance by the Owner of any Work or act not in accordance with the requirements of the Contract Documents.

9.11.5 No recourse shall be had against any member of the Board of Curators, or officer thereof, for any payment under the Contract or any claim based thereon.

ARTICLE 10

PROTECTION OF PERSONS AND PROPERTY

10.1 Safety Precautions and Programs

10.1.1 The Contractor shall at all times conduct operations under this Contract in a manner to avoid the risk of bodily harm to persons or risk of damage to any property. The Contractor shall promptly take precautions which are necessary and adequate against conditions created during the progress of the Contractor's activities hereunder which involve a risk of bodily harm to persons or a risk of damage to property. The Contractor shall continuously inspect Work, materials, and equipment to discover and determine any such conditions and shall be solely responsible for discovery, determination, and correction of any such conditions. The Contractor shall comply with applicable safety laws, standards, codes, and regulations in the jurisdiction where the Work is being performed, specifically, but without limiting the generality of the foregoing, with rules, regulations, and standards adopted pursuant to the Williams-Steiger Occupational Safety and Health Act of 1970 and applicable amendments.

10.1.2 The Contractor and all Subcontractors to the Contract must require all on-site employees to complete the ten-hour construction safety training program required under Section 292.675, RSMo, unless they have previously completed the program and have documentation of having done so. The Contractor will forfeit a penalty to the Owner of \$2,500 plus an additional \$100 for each employee employed by the Contractor or Subcontractor, for each calendar day, or

portion thereof, such employee is employed without the required training.” (Section 292.675, RSMo).

10.1.3 In the event the Contractor encounters on the site, material reasonably believed to be asbestos, polychlorinated biphenyl (PCB), lead, mercury, or other material known to be hazardous, which has not been rendered harmless, the Contractor shall immediately stop Work in the area affected and report the condition to the Owner’s Representative and the Architect in writing. The Work in the affected area shall not thereafter be resumed except by written agreement of the Owner’s Representative and the Contractor if in fact the material is asbestos or polychlorinated biphenyl (PCB) and has not been rendered harmless. The Work in the affected area shall be resumed in the absence of asbestos or polychlorinated biphenyl (PCB), or when it has been rendered harmless by written agreement of the Owner’s Representative and the Contractor. “Rendered Harmless” shall mean that levels of such materials are less than any applicable exposure standards, including but limited to OSHA regulations.

10.2 Safety Of Persons and Property

10.2.1 The Contractor shall take reasonable precautions for safety of, and shall provide protection to prevent damage, injury, or loss to:

- .1** students, faculty, staff, the public, construction personnel, and other persons who may be affected thereby;
- .2** the Work and materials and equipment to be incorporated therein, whether in storage on or off the site, under care, custody, or control of the Contractor or the Contractor’s Subcontractors of any tier; and
- .3** other property at the site or adjacent thereto, such as trees, shrubs, lawns, walks, pavements, roadways, structures, and utilities not designated for removal, relocation, or replacement in the course of construction.

10.2.2 The Contractor shall give notices and comply with applicable laws, standards, codes, ordinances, rules, regulations, and lawful orders of public authorities bearing on safety of persons or property or their protection from damage, injury, or loss.

10.2.3 The Contractor shall erect and maintain, as required by existing conditions and performance of the Contract, safeguards for safety and protection, including, but not limited to, posting danger signs and other warnings against hazards, promulgating safety regulations, and notifying owners and users of adjacent sites and utilities.

10.2.4 When use or storage of explosives or other hazardous materials or equipment or unusual methods are necessary for execution of the Work, the Contractor shall exercise the highest degree of care and carry on such activities under supervision of properly qualified personnel.

10.2.5 The Contractor shall promptly remedy damage and loss (other than damage or loss insured under property

insurance required by the Contract Documents) to property caused in whole or in part by the Contractor, a Subcontractor of any tier, or anyone directly or indirectly employed by any of them, or by anyone for whose acts they may be liable, and for which the Contractor is responsible under Article 10, except damage or loss attributable solely to acts or omissions of the Owner or the Architect or anyone directly or indirectly employed by either of them, or by anyone for whose acts either of them may be liable, and not attributable to the fault or negligence of the Contractor. The foregoing obligations of the Contractor are in addition to the Contractor’s other obligations stated elsewhere in the Contract.

10.2.6 The Contractor shall designate a responsible member of the Contractor’s organization at the site whose duty shall be the prevention of accidents, and the maintaining, enforcing and supervising of safety precautions and programs. This person shall be the Contractor’s superintendent unless otherwise designated by the Contractor in writing to the Owner’s Representative and the Architect. The Contractor shall hold regularly scheduled safety meetings to instruct the Contractor’s personnel on safety practices, accident avoidance and prevention, and the Project Safety Program. The Contractor shall furnish safety equipment and enforce the use of such equipment by its employees and its Subcontractors of any tier.

10.2.7 The Contractor shall not load or permit any part of the construction or site to be loaded so as to endanger its safety.

10.2.8 The Contractor shall promptly report in writing to the Owner all accidents arising out of or in connection with the Work which cause death, lost time injury, personal injury, or property damage, giving full details and statements of any witnesses. In addition, if death, serious personal injuries, or serious property damages are caused, the accident shall be reported immediately.

10.2.9 The Contractor shall promptly notify in writing to the Owner of any claims for injury or damage to personal property related to the Work, either by or against the Contractor.

ARTICLE 11 INSURANCE AND BONDS

11.1 Insurance

11.1.1 The Contractor shall secure from the date of the Contract for Construction and maintain for such periods of time as set forth below, insurance of such types and in such amounts specified below, to protect the Contractor, the Owner and others against all hazards or risks of loss described below. The form of such insurance together with carriers thereof, in each case, shall be approved by the Owner, but, regardless of such approval, it shall be the responsibility of the Contractor to maintain the insurance coverages set forth herein.

11.1.2 The Contractor shall not be allowed on the Owner's property without proof of the insurance coverages set forth herein

11.2 Commercial General Liability

11.2.1 The Contractor shall secure and maintain from the date of the Contract, and for a period of at least ten (10) years from the date of Final Completion of the entire Work, Commercial General Liability insurance ("CGL") with a combined single limit of not less than \$2,000,000 per occurrence, \$5,000,000 general aggregate, \$5,000,000 products and completed operations aggregate, and \$1,000,000 personal injury and advertising injury. General Aggregate must apply per project. An umbrella policy may be used to satisfy these limits.

11.2.2 CGL insurance shall be written on a Commercial form CG 00 01 or an equivalent form providing the same coverages and shall cover claims and liability in connection with or resulting from the Contractor's operations and activities under the Contract, for personal injuries, occupational sickness, disease, death or damage to property of others, including loss of use resulting therefrom, arising out of any operations or activities of the Contractor, its agents, or any Subcontractors of any tier or by anyone directly or indirectly employed by either of them.

11.2.3 CGL insurance shall include premises, operations, independent contractors, products-completed operations, personal injury and advertising injury and liability assumed under an insured contract (including the tort liability of another assumed in a business contract) coverages. In particular, and not by way of any limitation, the CGL insurance shall cover the Contractor's indemnity obligations contained in the Contract Documents.

11.2.4 There shall be no endorsement or modification of the CGL policy limiting the scope of coverage for liability arising from blasting, explosion, collapse, or underground property damage.

11.2.6 The Contractor waives all rights against the Owner and its agents, officers, representatives, and employees for recovery of damages to the extent those damages are covered by the CGL policy required hereunder.

11.3 Licensed for Use Vehicle Liability

11.3.1 The Contractor shall secure and maintain from the date of the Contract for Construction until the date of Final Completion of the entire Work, insurance, to be on comprehensive form, which shall protect the Contractor against any and all claims for all injuries and all damage to property arising from the use of automobiles, trucks and motorized vehicles, in connection with the performance of Work under this Contract, and shall cover the operation on or off the site of the Work of all motor vehicles licensed for

highway use whether they are owned, non-owned or hired. Such insurance shall include contractual liability coverage and shall provide coverage on the basis of the date of any accident. The liability limits under such policy shall not be less than \$2,000,000 combined single limit for bodily injury and property damage per accident.

11.3.2 The Contractor waives all rights against the Owner and its agents, officers, directors, and employees for recovery of damages to the extent such damages are covered by the automobile liability insurance required hereunder.

11.4 Workers' Compensation Insurance

11.4.1 The Contractor shall purchase and maintain workers' compensation insurance and employers' liability insurance which shall protect the Contractor from claims for injury, sickness, disease or death of the Contractor's employees or statutory employees. The insurance policies required hereunder shall include an "all states" or "other states" endorsement. In case any Work is subcontracted, the Contractor shall require any Subcontractor of any tier to provide the insurance coverages required under this Paragraph.

11.4.2 The Contractor's workers' compensation insurance coverage shall be in compliance with all applicable laws, including the statutes of the State of Missouri. The Contractor's employers' liability coverage limits shall not be less than \$1,000,000 each accident for bodily injury by accident or \$1,000,000 each employee for bodily injury by disease.

11.5 General Insurance Requirements and Professional Liability

11.5.1 Any Consultant/Contractor providing professional design services as part of the Contract shall be required to provide and maintain, from the date of this Contract and for a period of ten (10) years after the date of Final Completion, Professional Liability insurance, in a claims made form, to cover any claims, including but not limited to errors, omissions, and negligence, which may arise from the design and related services performed by the Consultant. The minimum limits for such policy shall be \$1,000,000.00 per claim/\$1,000,000.00 aggregate.

11.5.2 "The officers, employees, and agents of The Curators of the University of Missouri" shall be added as Additional Insured with respect to the CGL, umbrella/excess and Automobile Liability policies required herein. A certificate of insurance evidencing all coverage required is to be provided at least ten (10) days prior to the inception date of the Contract between the Contractor and the University. The Contractor is required to maintain coverages as stated and required to notify the University of a carrier change or cancellation within two (2) business days. The University reserves the right to request a copy of the policy. The University reserves the right to require higher limits on any contract provided notice of such requirement is stated in the request for proposals for such contract. The Contractor shall request that its insurer(s)

include the following disclaimer in any insurance policy, rider or endorsement issued pursuant to this Additional Insured requirement: "Neither the requirement for Additional Insured status nor any of the Contractor's action in compliance with such requirement, either direct or indirect, is intended to be and neither shall be construed as a waiver of any sovereign immunity, governmental immunity or any other type of immunity enjoyed by The Curators of the University of Missouri, the Board of Curators of the University of Missouri, or any of its officers, employees or agents."

The Additional Insured status must be conveyed by using the ISO CG 20 10 (2004) edition or equivalent and the ISO CG 20 37 (2004) edition. The policy shall be endorsed to be primary coverage and any other insurance carried by the Owner shall be excess only and will not contribute with Contractors' insurance. To confirm, the Endorsement should accompany the insurance certificate.

11.5.3 All insurance coverages procured by the Contractor shall be provided by agencies and insurance companies acceptable to and approved by Owner. All insurance coverage shall be provided by insurance companies that are duly licensed to conduct business in the State of Missouri as an admitted carrier, except that the Professional Liability insurance required herein may be provided by any insurance company legally authorized to do business in the State of Missouri. The form and content of all insurance coverage provided by the Contractor are subject to the approval of the Owner. All required insurance coverages shall be obtained and paid for by the Contractor. Any approval of the form, content or insurance company by the Owner shall not relieve the Contractor from the obligation to provide the coverages required herein. All insurance coverage procured by the Contractor shall be provided by insurance companies having policyholder ratings no lower than "A-" and financial ratings not lower than "XI" in the Best's Insurance Guide, latest edition in effect as of the date of the Contract, and subsequently in effect at the time of renewal of any policies required by the Contract Documents. Insurance coverages required hereunder shall not be subject to a deductible amount on a per-claim basis of more than \$10,000.00 and shall not be subject to a per-occurrence deductible of more than \$25,000.00. Insurance procured by the Contractor covering the Additional Insureds shall be primary insurance and any insurance maintained by Owner shall be excess insurance.

11.5.4 All insurance required hereunder shall provide that the insurer's cost of providing the insureds a defense and appeal, including attorneys' fees, shall be supplementary and shall not be included as part of the policy limits but shall remain the insurer's separate responsibility. The Contractor shall cause its insurance carriers for all required coverages, except for workers' compensation, to waive all rights of subrogation against the Owner and its officers, employees and agents.

11.5.5 The Contractor shall furnish the Owner with certificates, Additional Insured endorsements, policies, or binders which indicate the Contractor and/or the Owner and other Contractors (where required) are covered by the required insurance showing type, amount, class of operations covered, effective dates and dates of expiration of policies prior to commencement of the Work. The Contractor is required to maintain coverages as stated and required to notify the University of a carrier change or cancellation within two (2) business days. The University reserves the right to request a copy of the policy. The Contractor fails to provide, procure, and deliver acceptable policies of insurance or satisfactory certificates or other evidence thereof, the Owner may obtain such insurance at the cost and expense of the Contractor without notice to the Contractor.

11.5.6 With respect to all insurance coverages required to remain in force and affect after final payment, The Contractor shall provide the Owner additional certificates, policies and binders evidencing continuation of such insurance coverages along with the Contractor's application for final payment and shall provide certificates, policies and binders thereafter as requested by the Owner.

11.5.7 The maintenance in full current force and effect of such forms and amounts of insurance and bonds required by the Contract Documents shall be a condition precedent to the Contractor's exercise or enforcement of any rights under the Contract Documents.

11.5.8 Failure of the Owner to demand certificates, policies and binders evidencing insurance coverages required by the Contract Documents, approval by the Owner of such certificates, policies and binders or failure of the Owner to identify a deficiency from evidence that is provided by the Contractor shall not be construed as a waiver of the Contractor's obligations to maintain the insurance required by the Contract Documents.

11.5.9 The Owner shall have the right to terminate the Contract if the Contractor fails to maintain the insurance required by the Contract Documents.

11.5.10 If the Contractor fails to maintain the insurance required by the Contract Document, the Owner shall have the right, but not the obligation, to purchase said insurance at Contractor's expense. If the Owner is damaged by the Contractor's failure to maintain the insurance required by the Contract Documents, the Contractor shall bear all reasonable costs properly attributable to such failure.

11.5.11 By requiring the insurance set forth herein and in the Contract Documents, the Owner does not represent or warrant that coverage and limits will necessarily be adequate to protect the Contractor, and such coverages and limits shall not be deemed as a limitation on the Contractor's liability under the indemnities granted to the Owner in the Contract Documents. For those policies requiring the Owner to be added as an

Additional Insured, as set forth herein, the Owner and all other indemnified parties shall be an Additional Insured for the full limits carried by the Contractor, not just the limits required herein.

11.5.12 If Contractor's liability policies do not contain a standard separation of insureds provision, such policies shall be endorsed to provide cross-liability coverage.

11.5.13 If a part of the Work hereunder is to be subcontracted, the Contractor shall: (1) cover any and all Subcontractors in its insurance policies; (2) require each Subcontractor to secure insurance which will protect said Subcontractor and supplier against all applicable hazards or risks of loss designated in accordance with Article 11; and (3) require each Subcontractor or supplier to assist in every manner possible in the reporting and investigation of any accident, and upon request, to cooperate with any insurance carrier in the handling of any claim by securing and giving evidence and obtaining the attendance of witnesses as required by any claim or suit.

11.5.14 It is understood and agreed that the insurance coverages required by the provisions of this Contract are required in the public interest and that the Owner does not assume any liability for acts of the Contractor or Subcontractors of any tier or their employees in the performance of the Contract or Work.

11.6 Builder's Risk Insurance

11.6.1 The Contractor shall purchase and maintain, in a company or companies lawfully authorized to do business in the State of Missouri, as an admitted carrier, builder's risk insurance on the entire Work. Such insurance shall be written on a completed value form for the entire Work. The insurance shall apply on a replacement cost basis.

11.6.2 The insurance as required herein shall name as insureds the Owner, the Contractor, and all Subcontractors of any tier. The insurance policy shall contain a provision that the insurance will not be canceled, allowed to expire or materially changed until at least thirty (30) days prior written notice has been given to the Owner.

11.6.3 The insurance as required herein shall cover the entire Work, including reasonable compensation for Architect's services and expenses made necessary by an insured loss. Insured property shall include portions of the Work located away from the site (including all offsite stored materials) but intended for use at the site and shall also cover portions of the Work in transit. The policy shall include as insured property scaffolding, falsework, and temporary buildings located at the site. The policy shall cover the cost of removing debris, including demolition as may be made legally necessary by the operation of any law, ordinance, or regulation.

11.6.4 The insurance required herein shall be on an all risk form and shall be written to cover all risks of physical

loss or damage to the insured party and shall insure at least against the perils of fire and extended coverage, theft, vandalism, malicious mischief, collapse, lightening, earthquake, flood, frost, water damage, windstorm and freezing.

11.6.5 If there are any deductibles applicable to the insurance required herein, the Contractor shall pay any part of any loss not covered because of the operation of such deductibles.

11.6.6 The insurance as required herein shall be maintained in effect until the earliest of the following dates:

- .1** the date which all persons and organization who are insureds under the policy agree in writing that it shall be terminated;
- .2** the date on which final payment of this Contract has been made by the Owner to the Contractor; or
- .3** the date on which the insurable interests in the property of all insureds other than the Owner have ceased.

11.6.7 The Owner and the Contractor waive all rights against (1) each other and any of their Subcontractors of any tier, suppliers, agents and employees, each of the other, (2) the Architect and Architect's consultants, and (3) separate contractors described in Article 6, if any, and any of their subcontractors of any tier, suppliers, agents and employees, for damages caused by fire or other perils to the extent covered by property insurance or other insurance applicable to the Work, except such rights as they have to proceeds of such insurance. The Owner or the Contractor, as appropriate, shall require of the Architect, Architect's consultants, separate contractors described in Article 6, if any, and the Subcontractors of any tier, suppliers, agents, and employees of any of them, by appropriate agreements, written where legally required for validity, similar waivers each in favor of other parties enumerated herein. The policies shall provide such waivers of subrogation by endorsement or otherwise. A waiver of subrogation shall be effective as to a person or entity even though that person or entity would otherwise have a duty of indemnification, contractual or otherwise, did not pay the insurance premium directly or indirectly, was at fault or was negligent in causing the loss and whether or not the person or entity had an interest in the property damaged.

11.6.8 A loss insured under the Contractor's property insurance shall be adjusted by the Owner in good faith and made payable to the Owner for the insureds, subject to requirements of the Contract Documents. The Contractor shall pay Subcontractors of any tier their just shares of insurance proceeds received by the Contractor, and by appropriate agreements, written where legally required for validity, shall require Subcontractors of any tier to make payments to their Sub-subcontractors in similar manner. The Contractor shall waive its rights to subrogation for any loss or damage to the Contractor's property or equipment coverage in favor of the Owner and other indemnified parties.

11.7 Bonds

11.7.1 When the Contract Sum exceeds Fifty Thousand Dollars (\$50,000), the Contractor shall procure and furnish a Performance Bond and a Payment Bond in the form prepared by the Owner, each in an amount equal to one hundred percent (100%) of the Contract Sum, as well as adjustments to the Contract Sum. The Performance Bond shall secure and guarantee the Contractor's faithful performance of this Contract, including but not limited to the Contractor's obligation to correct defects after final payment has been made as required by the Contract Documents. The Payment Bond shall secure and guarantee payment of all persons performing labor on the Project under this Contract and furnishing materials in connection with this Contract. These Bonds shall be in effect through the duration of the Contract plus the Guaranty Period as required by the Contract Documents.

11.7.2 The bonds required hereunder shall be executed by a responsible surety licensed in the State of Missouri, with a Best's rating of no less than A-/XI. The Contractor shall require the attorney in fact who executes the required bonds on behalf of the surety to affix thereto a certified and current copy of this power of attorney indicating the monetary limit of such power.

11.7.3 If the surety of any bond furnished by the Contractor is declared bankrupt or becomes insolvent or its right to conduct business in the State of Missouri is terminated, or it ceases to meet the requirements of this Section, the Contractor shall within ten (10) days substitute another bond and surety, both of which must be acceptable to the Owner. If Contractor fails to make such substitution, the Owner may procure such required bonds on behalf of the Contractor at the Contractor's expense.

11.7.4 Upon the request of any person or entity appearing to be a potential beneficiary of bonds covering payment of obligations arising under the Contract, the Contractor shall promptly furnish a copy of the bonds to such person or entity.

11.7.5 The Contractor shall keep the surety informed of the progress of the Work, and, where necessary, obtain the surety's consent to or waiver of: (1) notice of changes in the Work; (2) request for reduction or release of retention; (3) request for final payment; and (4) any other material required by the surety. The Owner shall be notified by the Contractor, in writing, of all communications with the surety, as it relates to items one through four. The Owner may, in the Owner's sole discretion, inform surety of the progress of the Work, any defects in the Work, or any defaults of the Contractor under the Contract Documents and obtain consents as necessary to protect the Owner's rights, interest, privileges and benefits under and pursuant to any bond issued in connection with the Work.

11.7.6 The Contractor shall indemnify and hold harmless the Owner and any agents, employees, representative or member of the Board of Curators from and against any

claims, expenses, losses, costs, including reasonable attorneys' fees, as a result of any failure of the Contractor to procure the bonds required herein.

ARTICLE 12 UNCOVERING AND CORRECTION OF THE WORK

12.1 Uncovering of the Work

12.1.1 If a portion of the Work is covered contrary to the Architect's request or to requirements specifically expressed in the Contract Documents, it shall, if required in writing by the Architect or the Owner's Representative, be uncovered for the Architect's observation and be replaced at the Contractor's expense without change in the Contract Time.

12.1.2 If a portion of the Work has been covered which the Architect or the Owner's Representative has not specifically requested to observe, prior to its being covered, the Architect or the Owner's Representative may request to see such Work, and it shall be uncovered by the Contractor. If such Work is in accordance with the Contract Documents, costs of uncovering and replacement shall, by appropriate Change Order, be charged to the Owner. If such Work is not in accordance with the Contract Documents, the Contractor shall pay such costs unless the condition was caused by the Owner or a separate contractor in which event the Owner will be responsible for payment of such costs.

12.2 Correction of the Work

12.2.1 The Architect or the Owner's Representative shall have the right to reject Work not in strict compliance with the requirements of the Contract Documents. The Contractor shall promptly correct Work rejected by the Architect or the Owner's Representative for failing to conform to the requirements of the Contract Documents, whether observed before or after final completion and whether or not fabricated, installed, or completed. If Work has been rejected by the Architect or the Owner's Representative, the Architect or the Owner's Representative shall have the right to require the Contractor to remove it from the Project site and replace it with Work that strictly conforms to the requirements of the Contract Documents regardless, if such removal and replacement results in "economic waste." The Contractor shall pay all claims, costs, losses and damages caused by or resulting from the correction, removal or replacement of defective, or non-compliant Work, including but not limited to, all costs of repair or replacement of Work of others. The Contractor shall bear costs of correcting, removing and replacing such rejected Work, including additional testing and inspections and compensation for the Architect's services and expenses made necessary thereby. If prior to the date of final payment, the Contractor, a Subcontractor, or anyone for whom either is responsible uses or damages any portion of the Work, including, without limitation, mechanical, electrical, plumbing, and other building systems, machinery, equipment or other mechanical device, the Contractor shall cause such item to be restored to "like new" condition at no expense to the Owner.

12.2.2 If, within twelve (12) months after the date of Final Completion of the Work or designated portion thereof, or after the date for commencement of warranties, or by terms of an applicable special warranty required by the Contract Documents, any of the Work is found not to be in strict accordance with the requirements of the Contract Documents, the Contractor shall correct or remove and replace such defective Work, at the Owner's discretion. Such twelve (12) month period is referred to as the "Guarantee Period." The obligations under this Paragraph shall cover any repairs, removal, and replacement to any part of the Work or other property caused by the defective Work.

12.2.3 The Contractor shall remove from the site portions of the Work which are not in accordance with the requirements of the Contract Documents and are neither corrected by the Contractor nor accepted by the Owner.

12.2.4 If the Contractor fails to correct nonconforming Work within a reasonable time, the Owner may correct or remove it and replace such nonconforming Work. If the Contractor does not proceed with correction of such nonconforming Work within a reasonable time fixed by written notice from the Owner, the Owner may take action to correct or remove the nonconforming work at the Contractor's expense.

12.2.5 The Contractor shall bear the cost of correcting destroyed or damaged Work or property, whether completed or partially completed, of the Owner or of others caused by the Contractor's correction or removal of Work which is not in accordance with the requirements of the Contract Documents.

12.2.6 Nothing contained in Article 12 shall be construed to establish a period of limitation with respect to other obligations that the Contractor might have under the Contract Documents. Establishment of the twelve (12) month Guarantee Period as described in Article 12 relates only to the specific obligation of the Contractor to correct, remove or replace the Work, and has no relationship to the time within which the obligation to comply with the Contract Documents may be sought to be enforced, nor to the time within which proceedings may be commenced to establish the Contractor's liability with respect to the Contractor's obligations under the Contract Documents. The requirements of Article 12 are in addition to and not in limitation of any of the other requirements of the Contract for warranties or conformance of the Work to the requirements of the Contract Documents.

12.3 Acceptance of Nonconforming Work

12.3.1 The Owner may accept Work which is not in accordance with the Contract Documents, instead of requiring its removal and correction, in its sole discretion. In such case, the Contract Sum will be adjusted as appropriate and equitable. Such adjustment shall be made

whether or not final payment has been made. Nothing contained herein shall impose any obligation upon the Owner to accept nonconforming or defective Work.

ARTICLE 13 MISCELLANEOUS PROVISIONS

13.1 Written Notice

13.1.1 All notices required to be given by the Contractor under the terms of this Contract shall be made in writing. Written notice when served by the Owner will be deemed to have been duly served if delivered in person to the individual or a member of the firm or entity or to an office of the corporation for which it was intended, or if delivered at or sent to the last business address known to the party giving notice.

13.2 Rights and Remedies

13.2.1 Duties and obligations imposed by the Contract Documents and rights and remedies available thereunder shall be in addition to and not a limitation of duties, obligations, rights, and remedies otherwise imposed or available by law.

13.2.2 No action or failure to act by the Owner, the Architect, or the Owner's Representative will constitute a waiver of a right or duty afforded to the Owner under the Contract Documents, nor will such action or failure to act constitute approval of or acquiescence in a breach thereunder, except as may be specifically agreed in writing.

13.2.3 The terms of this Contract and all representations, indemnifications, warranties and guarantees made in, required by, or given in accordance with the Contract Documents, as well as all continuing obligations indicated in the Contract Documents, will survive final payment, completion and acceptance of the Work and termination or completion of the Work and shall remain in effect so long as the Owner is entitled to protection of its rights under applicable law.

13.2.4 The Contractor shall carry out the Work and adhere to the current construction schedule during all disputes or disagreements with the Owner. No Work shall be delayed or postponed pending resolution of any disputes or disagreements except as the Owner and the Contractor may otherwise agree to in writing.

13.3 Tests and Inspections

13.3.1 Tests, inspections, and approvals of portions of the Work required by the Contract Documents or by laws, ordinances, rules, codes, or regulations shall be made at an appropriate time. Unless otherwise provided, the Contractor shall make arrangements for such tests, inspections and approvals with an independent testing laboratory, the Owner's Authorized Agent, or entity acceptable to the Owner, and the Contractor shall bear related costs of tests, inspections, and approvals as required in the Contract Documents. The Contractor shall give the Architect, the Owner's Representative, and the Owner's Authorized Agent timely notice of when and where tests and inspections are to be made

so the Architect, the Owner's Representative and/or the Owner's Authorized Agent may observe procedures or perform the necessary tests or inspections.

13.3.2 If the Architect, the Owner's Representative, or the Owner's Authorized Agent determine that portions of the Work require additional testing, inspection or approval not included in the Contract Documents, or required by law, the Architect, or the Owner's Representative will instruct the Contractor to make arrangements for such additional testing, inspection, or approval by an entity acceptable to the Owner's Representative and the Contractor shall give timely notice to the Architect, the Owner's Representative or the Owner's Authorized Agent, of when and where tests and inspections are to be made so the Architect, the Owner's Representative and/or the Owner's Authorized Agent, may choose that the tests or inspections can be performed or observed. The Owner will bear such costs except as provided elsewhere in Article 13.

13.3.3 If such procedures for testing, inspection, or approval under Article 13 reveal failure of the portions of the Work to comply with requirements established by the Contract Documents, the Contractor shall bear all costs made necessary by such failure including those of repeated procedures and compensation for the Architect's and Owner's Authorized Agent's services and expenses.

13.3.4 Required certificates of testing, inspection, or approval shall, unless otherwise required by the Contract Documents, be secured by the Contractor, and promptly delivered to the Owner's Representative and the Architect.

13.3.5 The Contractor shall take all necessary actions to ensure that all tests or inspections conducted pursuant to the Contract Documents shall be made promptly to avoid unreasonable delay in the Work.

13.3.6 The Contractor shall arrange for and pay for all costs of all testing required by the Contract Documents or any applicable laws for materials to be tested or certified at or on the place or premises of the source of the material to be supplied. The Owner shall have the right to require testing of all materials at the place of the source of the material to be supplied if not required by the Contract Documents or any applicable laws. The Owner shall bear the costs of such tests and inspections not required by the Contract Documents or by applicable laws, unless prior defective Work provides the Architect or the Owner with a reasonable belief that additional defective Work may be found, in which case the Contractor shall be responsible for all costs of tests and inspections ordered by the Owner or the Architect, whether or not such tests or inspection reveals that Work is in compliance with the Contract Documents.

13.4 Nondiscrimination in Employment Equal Opportunity

13.4.1 The University serves from time to time as a contractor for and/or receives funds from the United States

government. Accordingly, the Contractor shall comply with applicable federal laws, rules, and regulations, including those relating to nondiscrimination, equal employment opportunity, and affirmative action in the employment of certain entities or individuals, including, but not limited to, minorities (Executive Order 11246), women (Executive Order 11375), persons with disabilities (29 USC 706 and Executive Order 11758), and certain veterans (38 USC 4212 formerly [2012]), and those related to contracting with small or disadvantaged business concerns (Publication L. 95-507). Contract clauses required by the Federal Government in such circumstances are incorporated herein by reference.

13.4.2 If applicable, the Contractor shall comply with the equal opportunity requirements of 41 CFR Part 60, which are incorporated into this Contract by reference.

13.5 Supplier Diversity Participation Goals

13.5.1 The Contractor shall provide participation of Diverse Firms in the Project, through self-performance, if a Diverse Firm, or by subcontracting with Diverse Firms as Subcontractors, suppliers or manufacturers, in an amount that is no less than the percent of Contract Sum that was promised in the Contractor's bid and/or the amount accepted by the Owner.

13.5.2 If the Contractor must remove any Diverse Firm as a Subcontractor, supplier or manufacturer under the Contract, the Contractor shall replace the Diverse Firm with one or more Diverse Firms in an amount equal to the dollar value of the work awarded to the Diverse Firm that was removed. The Contractor shall immediately notify the Owner's Representative in writing of the Contractor's intent to remove any Diverse Firm as a Subcontractor, supplier or manufacturer, and the Contractor's plan to provide the promised amount of Supplier Diversity Participation. All changes of a Diverse Firm as a Subcontractor of any tier, supplier or manufacturer under the Contract shall be approved by the Executive Director of Facilities Planning and Development.

13.5.3 If the Contractor fails to meet or to maintain the promised amount of Supplier Diversity Participation, the Contractor shall immediately notify in writing the Owner's Representative and the Executive Director of Facilities Planning and Development. Such notice shall include a description of the Contractor's good faith effort to provide the promised Supplier Diversity Participation.

13.5.4 If the Executive Director of Facilities Planning and Development finds that the Contractor has failed to comply in good faith with the promised Supplier Diversity Participation the Executive Director may take appropriate action, including but not limited to, declaring the Contractor ineligible to participate in any contracts with the Owner for a period not to exceed six (6) months, and/or directing that the Contractor's actions be declared a material breach of the Contract and that the Contract be terminated.

13.5.5 The Contractor and his Subcontractors shall develop, implement, maintain, and submit in writing to the Executive Director of Facilities Planning and Development, an affirmative action program if at least fifty (50) persons in the aggregate are employed under this Contract. If less than fifty (50) persons in the aggregate are to be employed under this Contract, the Contractor shall submit, in lieu of the written affirmative action program, a properly executed "Affidavit for Affirmative Action" in the form as included in the Contract Documents. For the purpose of this Section, an "Affirmative Action Program" means positive actions to influence all employment practices (including, but not limited to, recruiting, hiring, promoting, and training) in providing equal employment opportunity regardless of race, color, sex, national origin, religion, age (where the person affected is between 40 and 70), disabled and Vietnam-era veteran status, and handicapped otherwise qualified status. Such affirmative action program shall include:

.1 A written policy statement committing the total organization to affirmative action and assigning management responsibilities and procedures for evaluation and dissemination.

.2 The identification of a person designated to handle action.

.3 The establishment of non-discriminatory selection standards, objective measures to analyze recruitment, an upward mobility system, a wage and salary structure, and standards applicable to lay-off, recall, discharge, demotion, and discipline.

.4 The exclusion of discrimination from collective bargaining agreements.

.5 Performance of an internal audit of the reporting system to monitor execution and to provide for future planning.

13.5.6 In the enforcement of the non-discrimination requirements in Section 13.4 and 13.5, the Owner may use any reasonable procedures available, including but not limited to: requests, reports, site visits, and inspection of relevant documents of Contractors and Subcontractors of any tier. The Contractor shall submit a final Affidavit of Diversity Participation for each Diverse Firm at the end of the project stating the actual amount paid to the Diverse Firm.

13.6 Wage Rates (If the Contract amount is less than \$75,000, the requirements of this Section will not apply. Any adjustments that increase the Contract cost above \$75,000 will be subject to this Section, per Section 290.230, RSMo.)

13.6.1 The Contractor and its Subcontractors shall pay all workers performing work under the Contract not less than the prevailing hourly rate of wages or the public works contracting minimum wage, whichever is applicable, as set out in the Annual Wage Order that is attached to and made part of the specifications for work under the Contract, in accordance with Sections 290.210 to 290.340, RSMo

(Missouri Prevailing Wage Law) and related regulations. The Annual Wage Order(s) published by the Missouri Department of Labor and Industrial Relations (MDLIR) for the location where the Work is performed is incorporated into the Contract by this reference. The Contractor shall use applicable MDLIR regulations, including, but not limited to, 8 CSR 30-3.010-3.060, in determining the appropriate occupational titles and rates for workers used in the execution of this Contract. All determinations and/or interpretations regarding wage rates and classification of workers will be made by the office of the University of Missouri Executive Director of Facilities Planning and Development.

13.6.2 If this Project is financed in whole or in part from Federal funds (as indicated in the bid or Contract Documents), then this Contract shall be subject to all applicable federal labor statutes, rules, and regulations, including provisions of the Davis-Bacon Act, 40 U.S.C. § 3141 et seq., and the "Federal Labor Standards Provisions." Where the Missouri Prevailing Wage Law and the Davis-Bacon Act require payment of different wages for work performed under this Contract, the Contractor and all Subcontractors shall pay the greater of the wages required under either law, on a classification-by-classification basis.

13.6.3 The Contractor will forfeit a penalty to the Owner of \$100 per day (or portion of a day) for each worker that is paid less than the specified rate for any work done under the Contract by the Contractor or by any Subcontractor. The Owner shall deduct from any unpaid amounts then or thereafter due the Contractor under the Contract all sums and amounts due and owing as a result of any violation of Sections 290.210 to 290.340, RSMo. (Section 290.250, RSMo) The Contractor agrees to abide by any decision made by the Owner regarding underpayment of wages to workers and amounts owed them as well as penalties for underpayment of wages.

13.6.4 The prevailing wage rate(s) and public works contracting minimum wage(s) included in the Annual Wage Order(s) include fringe benefits as set forth in Sections 290.219 and 290.257, RSMo. Fringe benefit payments may be made to the worker in cash, or irrevocably made by a Contractor or Subcontractor to a trustee or to a third person pursuant to a fund, plan or program, or pursuant to an enforceable commitment, or any combination thereof, to carry out a financially responsible plan or program which was communicated in writing to the workmen affected, for medical or hospital care, pensions on retirement or death, compensation for injuries or illness resulting from occupational activity, or insurance to provide any of the foregoing, for unemployment benefits, life insurance, disability and sickness insurance, accident insurance, for vacation and holiday pay, for defraying costs of apprenticeship or other similar programs, or for other bona fide fringe benefits, but only where the Contractor or Subcontractor is not required by other federal or state law to provide any of the benefits as referenced in Section 290.210(5), RSMo.

13.6.5 The Contractor shall make full payment of the applicable required wages to workers in legal tender. Pay for travel, mileage, meals, bonuses, or other expenses are not fringe benefits and cannot be considered part of the workers wage rate. The Contractor shall not make any deductions for food, sleeping accommodations, transportation, use of small tools, uniforms, or anything of any kind or description, unless the Contractor and employee enter into an agreement in writing at the beginning of the worker's term of employment, and such agreement is approved by the Owner as fair and reasonable in accordance with Section 290.315, RSMo.

13.6.6 The Contractor shall submit to the Owner with the Contractor's periodic pay request, certified payroll records for labor performed by the Contractor and Subcontractors of any tier. The Contractor shall submit all required certified payroll information records electronically in pdf format using the Owner's web-based payment program. The certified payroll forms shall contain the name, address, personal identification number, and occupational title of the workers as well as the hours they work each day. Do not include personal social security numbers in payroll records. The Owner's acceptance of certified payroll records does not in any way relieve the Contractor of any responsibility for the payment of prevailing wages to workers on the project. The Contractor shall also maintain copies of the certified payroll records. The Owner may, at any time, request copies of, and/or inspect all of the Contractor's payroll records for the Work to verify compliance. The Contractor shall furnish the Owner copies of payroll records within ten (10) days of the Owner's written request. The Contractor shall provide copies of workers I-9 forms within twenty-four (24) hours of written notice. Such payroll records shall be maintained in accordance with Article 13.7.1 and shall be available for inspection for two (2) years after final completion of the Work. Falsification of the certified payroll records may result in the debarment of the Contractor or Subcontractor from future work with the University.

13.6.7 If applicable, the Contractor shall comply with the Copeland "Anti-Kick Act, 18 U.S.C. § 874, 40 U.S.C. § 3145, and the requirements of 29 C.F.R. pt. 3 as may be applicable, which are incorporated by reference into this contract.

13.6.8 The Contractor shall specifically incorporate the obligations of Section 13.6 into the subcontracts, supply agreements and purchase orders for the Work and require the same of any Subcontractors of any tier.

13.6.9 If Contractor fails to comply with the provisions of Section 13.6 of this Contract or with Sections 290.210 to 290.340, RSMo and related regulations, the Owner may, in its sole discretion, immediately terminate the Contract upon written notice. The rights and remedies of the Owner provided herein shall not be exclusive and are in addition

to other rights and remedies provided by law or under this Contract.

13.6.10 The Contractor may pay entry-level workers or federally-registered apprentices fifty percent (50%) of the pay of a journeyman in their same occupational title, in accordance with Section 290.235, RSMo and 8 CSR 30-3.030. Per 8 CSR 30-3.030, an entry-level worker is "[a]ny worker who is not a journeyman and who is not otherwise enrolled in a federally-registered apprenticeship program but is participating in an on-the-job training program provided by the contractor for whom they perform work on a public construction project." The University of Missouri may require documentation showing, to the University's sole satisfaction, that an entry-level worker is participating in an on-the-job training program with the Contractor. The combined total of such entry-level workers and federally registered apprentices shall not exceed a one-to-one ratio with the number of journeyman workers in any occupational title on the project.

13.6.11 The Contractor shall post the wage rates for the Contract in a dry, accessible place at the field office on the project or, where there is no field office, at the Contractor's local office or batch plant so long as a copy is provided to workers upon request, as required by 8 CSR 30-3.050. The wage rates shall be kept in a clearly legible condition for the duration of the project.

13.6.12 Neither the Contractor, nor any Subcontractor of any tier, nor any person hired by them or acting on their behalf, shall request, demand or receive, either before or after such worker is engaged, that such worker pay back, return, donate, contribute, or give any part or all of said worker's wages, salary, or thing of value, to any person, upon the statement, representation, or understanding that failure to comply with such request or demand will prevent such worker from procuring or retaining employment, and no person shall, directly or indirectly, pay, request or authorize any other person to violate this Section as set forth in Section 290.305, RSMo, the exception being to an agent or representative of a duly constituted labor organization acting in the collection of dues or assessments of such organization. No Contractor or Subcontractor may directly or indirectly receive a wage subsidy, bid supplement, or rebate for employment on this project if such wage subsidy, bid supplement, or rebate has the effect of reducing the wage rate paid by the employer on a given occupational title below the applicable wage rate as provided in the Contract. In the event a wage subsidy, bid supplement, or rebate is provided or received, the entity receiving such subsidy, supplement, or rebate shall report the date and amount of such subsidy, supplement, or rebate to the University within thirty days of receipt of payment. This disclosure report shall be a matter of public record.

13.6.13 The Contractor will pay workers overtime for all hours worked over ten (10) hours per day and forty (40) hours per week in accordance with Section 290.230, RSMo. For all overtime work performed, not less than one and one-half the prevailing hourly rate of wages for work of a similar character

in the locality in which the Work is performed or the public works contracting minimum wage, whichever is applicable, shall be paid. For all work performed on a Sunday or holiday, not less than twice the prevailing hourly rate of pay or public works contracting minimum wage will apply in accordance with Section 290.230, RSMo. For purposes of this Section, holidays are as follows: January first, the last Monday in May, July fourth, the first Monday in September, November 11, the fourth Thursday in November, December twenty-fifth. If any holiday falls on a Sunday, the following Monday shall be considered a holiday.

13.7Records

13.7.1 The Owner, or any parties it deems necessary, shall have access to and the right to examine any accounting or other records of the Contractor involving transactions and Work related to this Contract for five (5) years after final payment or five (5) years after the final resolution of any on going disputes at the time of final payment. All records shall be maintained in accordance with generally accepted accounting procedures, consistently applied. Subcontractors of any tier shall be required by Contractor to maintain records and to permit audits as required of Contractor herein.

13.8Codes and Standards

13.8.1 The Work shall be performed to comply with the International Code Council (ICC) Codes, and the codes and standards noted below. The latest editions and supplements of these codes and standards in effect on the date of the execution of the Contract for Construction shall be applicable unless otherwise designated in the Contract Documents. Codes and standards required by accreditation agencies will also be used unless the ICC requirements are more stringent. In the event that special design features and/or construction systems are not covered in the ICC codes, the applicable edition of the National Fire Protection Association (NFPA) family of standards and/or the NFPA 101 Life Safety Code shall be used.

- .1** ICC International Building Code and reference standards
- .2** ICC International Plumbing Code
- .3** ICC International Mechanical Code
- .4** ICC International Fire Code
- .5** ICC International Fuel Gas Code
- .6** NFPA 70 National Electric Code (NEC)
- .7** Americans with Disabilities Act – Standards for Accessible Design.
- .8** American National Standard Safety Code for Elevators, Dumbwaiters, Escalators, and Moving Walks as published by the American Society of Mechanical Engineers (ASME), American National Standards Institute (ANSI) A17.1
- .9** NFPA 101 Life Safety Code (as noted above)
- .10** American Concrete Institute (ACI)
- .11** American National Standards Institute (ANSI)
- .12** American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

- .13** American Refrigeration Institute (ARI)
- .14** American Society for Testing and Materials (ASTM)
- .15** Missouri Standard Specification for Highway Construction, Missouri State Highway Commission
- .16** National Electrical Manufacturers Association (NEMA)
- .17** Underwriter's Laboratories, Inc. (UL), Federal Specifications
- .18** Williams Steiger Occupational Safety and Health Act of 1970 (OSHA)

13.9 General Provisions

13.9.1 Any specific requirement in this Contract that the responsibilities or obligations of the Contractor also apply to a Subcontractor is added for emphasis and are also hereby deemed to include a Subcontractor of any tier. The omission of a reference to a Subcontractor in connection with any of the Contractor's responsibilities or obligations shall not be construed to diminish, abrogate or limit any responsibilities or obligations of a Subcontractor of any tier under the Contract Documents or the applicable subcontract.

13.9.2 This Contract shall be interpreted, construed, enforced, and regulated under and by the laws of the State of Missouri. Whenever possible, each provision of this Contract shall be interpreted in a manner as to be effective and valid under applicable law. If, however, any provision of this Contract, or a portion thereof, is prohibited by law or found invalid under any law, only such provision or portion thereof shall be ineffective, without invalidating or affecting the remaining provisions of this Contract or valid portions of such provision, which are hereby deemed severable. The Contractor and the Owner further agree that in the event any provision of this Contract, or a portion thereof, is prohibited by law or found invalid under any law, this Contract shall be reformed to replace such prohibited or invalid provision or portion thereof with a valid and enforceable provision which comes as close as possible to expressing the intention of the prohibited or invalid provision.

13.9.3 The Contractor and the Owner each agree that the State of Missouri Circuit Court for the County where the Project is located shall have exclusive jurisdiction to resolve all Claims and any issue and disputes between the Contractor and the Owner. The Contractor agrees that it shall not file any petition, complaint, lawsuit or legal proceeding against the Owner in any other court other than the State of Missouri Circuit Court for the County where the Project is located.

13.9.4 The Owner's total liability to the Contractor and anyone claiming by, through, or under the Contractor for any Claim, cost, loss, expense, or damage caused in part by the fault of the Owner and in part by the fault of The Contractor or any other entity or individual shall not exceed the percentage share that the Owner's fault bears to the total fault of the Owner, the Contractor and all other entities and individuals as determined on the basis of comparative fault principles.

13.9.5 The Contractor agrees that the Owner shall not be liable to the Contractor for any special, indirect, incidental, or

consequential damage whatsoever, whether caused by the Owner's negligence, fault, errors or omissions, strict liability, breach of contract, breach of warranty or other cause or causes whatsoever. Such special, indirect, incidental or consequential damages include, but are not limited to loss of profits, loss of savings or revenue, loss of anticipated profits, labor inefficiencies, idle equipment, home office overhead, and similar types of damages.

13.9.6 Nothing contained in this Contract or the Contract Documents shall create any contractual relationship with or cause of action in favor of a third party against the Owner.

13.9.7 No member or officer of the Board of Curators of the University incurs or assumes any individual or personal liability under the Contract or by reason of the default of the Owner in the performance of any terms thereof. The Contractor releases and discharges all members or officers of the Board of Curators of the University from any liability as a condition of and as consideration for the award of the Contract to the Contractor.

13.9.8 The Contractor hereby binds itself, its partners, successors, assigns and legal representatives to the Owner in respect to covenants, agreements and obligations contained in the Contract Documents. The Contractor shall not assign the Contract or proceeds hereof without written consent of the Owner. If the Contractor attempts to make such an assignment without such consent, it shall be void and confer no rights on third parties, and the Contractor shall nevertheless remain legally responsible for all obligations under the Contract. The Owner's consent to any assignment is conditioned upon the Contractor entering into a written assignment which contains the following language: "It is agreed that the funds to be paid to the assignee under this assignment are subject to performance by the Contractor and to claims and to liens for services rendered or materials supplied for the performance of the Work required in said Contract in favor of all persons, firms, corporations rendering such services or supplying such materials."

13.10 Certifications

13.10.1 Suspension and Debarment

The Contractor certifies to the best of its knowledge and belief that it and its principals are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any department or agency in accordance with Federal Executive Orders 12549 (2/18/86) and 12689 (8/15/89).

13.10.2 Anti-Discrimination Against Israel Act

If this Contract is for \$100,000 or more, and if the Contractor is a company with ten (10) or more employees, then Contractor certifies that it, and any company affiliated with it, does not boycott Israel, and will not boycott Israel during the term of this Contract. In this Paragraph, the terms "company" and "boycott Israel" shall have the meanings described in Section 34.600 of the Missouri Revised Statutes.

13.10.3 Byrd Anti-Lobbying Amendment

.1 If this Contract exceeds \$100,000 and is funded by Federal funding, Contractor agrees to file the required certification, in compliance with 31 U.S.C. § 1352 (as amended).

.2 Each tier certifies to the tier above that it will not and has not used Federal appropriated funds to pay any person or organization for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, officer or employee of Congress, or an employee of a Member of Congress in connection with obtaining any Federal contract, grant, or any other award covered by 31 U.S.C. § 1352.

.3 Each tier shall also disclose any lobbying with non-Federal funds that takes place in connection with obtaining any Federal award. Such disclosures are forwarded from tier to tier up to the recipient who in turn will forward the certification(s) to the awarding agency.

13.10.4 Work Authorization

The Contractor and all subcontractors performing work under this Contract shall enroll and participate in a federal work authorization program operated by the United States Department of Homeland Security, E-Verify or an equivalent federal work authorization program, to verify information of newly hired employees, under the Immigration Reform and Control Act of 1986 (IRCA), P.L.99-603. By executing a contract with The Curators of the University of Missouri, the Contractor shall affirm its enrollment and participation in a federal work authorization program with respect to the employees working in connection with the contracted service and affirm that it does not knowingly employ any person who is an unauthorized alien in connection with the contracted services. The Contractor shall maintain documentation of its participation in a federal work authorization program and make such documentation available to the University upon request.

ARTICLE 14 TERMINATION OR SUSPENSION OF THE CONTRACT

14.1 Termination by Owner for Cause

14.1.1 In addition to other rights and remedies granted to the Owner under the Contract Documents and by law, the Owner may terminate the Contract if the Contractor:

.1 refuses or fails to supply enough properly skilled workers, superintendents, foremen, or managers;

.2 refuses or fails to supply sufficient or proper materials;

.3 fails to make payment to Subcontractors for materials or labor in accordance with the respective agreements between the Contractor and the Subcontractors;

.4 disregards laws, ordinances, rules, codes, regulations or orders of an authority having jurisdiction;

.5 disregards the authority of the Owner's Representative, the Architect, or the Owner's Authorized Agent;

.6 breaches any warranty or representations made by the Contractor under or pursuant to the Contract Documents;

.7 fails to furnish the Owner with assurances satisfactory to the Owner evidencing the Contractor's ability to complete the Work in compliance with all the requirements of the Contract Documents;

.8 fails after commencement of the Work to proceed continuously with the construction and completion of the Work for more than ten (10) days, except as permitted under the Contract Documents;

.9 fails to maintain a satisfactory rate of progress with the Work or fails to comply with approved progress schedules; or

.10 violates in any substantial way any provisions of the Contract Documents.

14.1.2 When any of the above reasons exist, the Owner may, without prejudice to any other rights or remedies of the Owner, terminate this Contract by delivering a written notice of termination to the Contractor and the Contractor's surety, and may:

.1 take possession of the site and of all materials, equipment, tools, and construction equipment and machinery thereon owned by the Contractor;

.2 accept assignment of subcontracts pursuant to Section 5.3; and

.3 finish the Work by whatever reasonable method the Owner may deem expedient, including turning the Work over to the surety.

14.1.3 The Contractor, in the event of a termination under Section 14.1, shall not be entitled to receive any further payments under the Contract until the Work is completed in its entirety. Then, if the unpaid balance under the Contract shall exceed all expenses of the Owner in finishing the Work, including additional compensation for the Architect's services and expenses made necessary thereby, such excess will be paid to the Contractor; but, if such expenses of the Owner to finish the Work shall exceed the unpaid balance, the Contractor and its surety shall be liable for, and shall pay the difference and any damages to the Owner. The obligation of the Contractor and its surety for payment of said amounts shall survive termination of the Contract.

14.1.4 In exercising the Owner's right to secure completion of the Work under any of the provisions hereof, the Owner shall have the right to exercise the Owner's sole discretion as to the manner, methods, and reasonableness of costs of completing the Work.

14.1.5 The rights of the Owner to terminate pursuant to Article 14.1 will be cumulative and not exclusive and shall be in addition to any other remedy provided by law or the Contract Documents.

14.1.6 Should the Contractor fail to achieve Final Completion of the Work within thirty (30) calendar days following the date of Substantial Completion, the Owner may exercise its rights under Section 14.1.

14.2 Suspension by the Owner for Convenience

14.2.1 The Owner may, without cause, order the Contractor in writing to suspend, delay, or interrupt the Work in whole or in part for such period of time as the Owner may determine.

14.2.2 An adjustment will be made to the Contract Sum for increases in the cost of performance of the Contract caused by suspension, delay or interruption. However, in the event of a suspension under Section 14.2, Contractor hereby waives and forfeits any claims for payment of any special, indirect, incidental or consequential damages such as lost profits, loss of savings or revenue, loss of anticipated profits, idle labor or equipment, home office overhead, and similar type damages. No adjustment will be made to the extent:

.1 that performance is, was, or would have been so suspended, delayed or interrupted by another cause for which the Contractor in whole or in part is responsible, or

.2 that an equitable adjustment is made or denied under another provision of this Contract.

14.3 Owner's Termination for Convenience

14.3.1 The Owner may, at any time, terminate the Contract in whole or in part for the Owner's convenience and without cause. Termination by the Owner under this Paragraph shall be by a notice of termination delivered to the Contractor specifying the extent of termination and the effective date.

14.3.2 Upon receipt of a notice of termination for convenience, the Contractor shall immediately, in accordance with instructions from the Owner, proceed with performance of the following duties regardless of delay in determining or adjusting amounts due under this Paragraph:

.1 cease operation as specified in the notice;

.2 place no further orders and enter into no further subcontracts for materials, labor, services or facilities except as necessary to complete Work not terminated;

.3 terminate all subcontracts and orders to the extent they relate to the Work terminated;

.4 proceed to complete the performance of Work not terminated; and

.5 take actions that may be necessary, or that the Owner may direct, for the protection and preservation of the terminated Work.

14.3.3 Upon such termination, the Contractor shall recover as its sole remedy payment for Work properly performed in connection with the terminated portion of the Work prior to the effective date of termination and for items properly and timely fabricated off the Project site, delivered and stored in accordance with the Owner's instructions and for all Owner approved claims, costs, losses and damages incurred in settlement of terminated contracts with Subcontractors and suppliers. The Contractor hereby waives and forfeits all other claims for payment and damages, including, without limitation, anticipated profits, consequential damages and other economic losses.

14.3.4 The Owner shall be credited for (1) payments previously made to the Contractor for the terminated portion of

the Work, (2) claims which the Owner has against the Contractor under the Contract and (3) the value of the materials, supplies, equipment, or other items that are to be disposed of by the Contractor that are part of the Contract Sum.

14.3.5 Upon determination by a court that termination of Contractor or its successor in interest pursuant to Section 14.1 was wrongful, such termination will be deemed converted to a termination for convenience pursuant to Section 14.3, and Contractor's sole and exclusive remedy for wrongful termination is limited to recovery of the payments permitted for termination for convenience as set forth in 14.3.

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SECTION 1.E
SPECIAL CONDITIONS

1. DEFINITIONS

- a. "Drawings":
Drawings referred to in and accompany Project Manual consist of Drawings prepared by and bearing the name of the below defined Architect, bearing date of July 8, 2025, entitled "MEDICAL SCIENCE BUILDING 7E RENOVATION", project number CP2400920. Note that there are two separate drawing packages associated with this contract outlining two separate renovation scenarios. Refer to "Option L" and "Option M" designations throughout the documents to differentiate these two renovation scenarios.

- b. Architect:
PGAV Architects
4900 Main Street #1000
Kansas City, MO 64112
(913) 362-6500
Email: james.ice@pgav.com

- c. Mechanical & Plumbing Engineer:
Introba
6 South Old Orchard Ave,
Webster Groves, MO 63119
(314) 391-5779
Email: randy.diemer@introba.com

- d. Electrical Engineer:
Antella Consulting Engineers Inc.
1600 Genessee, Suite 733
Kansas City, MO 64102
(816) 421-0950
Email: msantos@antella-inc.com

- e. Structural Engineer:
Bob D. Campbell & Co.
4338Bellevue Ave.
Kansas City, MO 64111
(816) 531-4144
Email: sbrooks@bdc-engrs.com

- f. Normal Business Hours:
For purposes of this contract, normal business hours shall be defined as 8:00am to 6:00pm, Monday through Friday.

g. Other Definitions: See Article 1., General Conditions

2. SPECIAL SCHEDULING REQUIREMENTS

a. Special scheduling requirements supplemental to the bid form are included as follows:

- (1) Contractor may perform all work under this contract during normal business hours, except that all work in public corridors and occupied spaces shall be performed outside of normal business hours, including any accepted bid alternates.
- (2) Coordinate all work in Lab M702 with Owner's representative. Work in Lab M702 shall be completed as quickly and efficiently as possible to minimize operational disruption.
- (3) Contractor shall coordinate scheduling of all after hours work with the Owner's representative prior to commencing work.
- (4) Contractor shall coordinate scheduling of utility outages with Owner's Representative. See MEPT Shutdown Matrix template in Section 1.J. Provide 5 working day notice for any and all utility shutdowns.
- (5) Contractor shall coordinate with Owner's furniture vendor in scheduling installation of Fixtures, Furnishings and Equipment provided and installed under separate contract.

3. SCOPE OF WORK

a. The Contractor shall furnish all labor, materials, tools, equipment necessary for, and incidental to, construction of this project as indicated on the Drawings and specified herein.

b. Work shall include everything requisite and necessary to finish work properly, notwithstanding that every item of labor or materials or accessories required to make project complete may not be specifically mentioned.

c. General Description of Work:

- (1) Project consists of renovations to level 7 east wing in the existing Medical Science Building. The project includes two base bid renovation scenarios referred to as "Option L" and "Option M", both of which include new walls, finishes, ceiling, lighting, electrical, plumbing, and mechanical configurations.
- (2) Demolition shall consist of removal of existing finishes, ceilings, lighting, and interior walls as indicated. Note that Option 'L' also includes surface cleaning and decontamination of walls, floors, and overhead structure where indicated.
- (3) Architectural work for Option 'M' shall consist of reconfigured walls, new doors, flooring, wall finishes, ceiling finishes, and lab casework, lab equipment, and lab

containment devices. Refer to Option 'M' drawings.

- (4) Architectural work for Option 'L' shall consist of replacement of existing walls, doors, flooring, wall finishes, ceiling finishes, lab casework, lab equipment, and lab containment devices. Refer to Option 'L' drawings.
- (5) Structural work shall consist of infilling existing holes in the concrete slab on the 7th floor and roof slab above, and cutting new roof penetrations for mechanical exhaust ductwork. Refer to structural drawings.
- (6) Fire Protection for Option 'M' shall consist of a complete code compliant automatic wet pipe system throughout the east wing as indicated, with alternates to expand the fire protection scope to other parts of the 7th floor. Refer to fire protection drawings.
- (7) Fire Protection for Option 'L' shall consist of replacing existing fire sprinkler mains if undersized or in poor condition based on leak testing and hydraulic calculations. Refer to fire protection drawings.
- (8) Plumbing work shall consist of piping demolition and rework of cold and hot water pipes, DI water, compressed air, lab vac, and lab gas pipes in 7th floor east wing. Option 'M' also includes alternate piping demolition and rework extending into central corridor and NE corridor and adjacent lab spaces, and alternate piping for the restroom renovation. Refer to plumbing drawings.
- (9) Mechanical work shall consist of removal and replacement of all ductwork and mechanical piping in the east wing on level 7, and selective removal / replacement of ductwork on the roof. Alternates include removal and replacement of ductwork and piping in the central corridor, adjacent labs, and restrooms on 7th floor. Refer to mechanical drawings.
- (10) Electrical work shall consist of removal and replacement of all lighting and electrical devices in the east wing on 7th floor. Option 'L' alternates include LED fixtures in lieu of fluorescent retrofit fixtures. Option 'M' alternates include removal and replacement of lighting in the central corridor, adjacent labs, and restrooms on 7th floor. Refer to electrical drawings.

4. LOCATION

- a. Work shall be performed under this Contract on the campus of the University of Missouri – Columbia, Medical Science Building located at 7 Hospital Drive.

5. NUMBER OF CONSTRUCTION DOCUMENTS

- a. The Owner's Representative will furnish the Contractor a copy of the executed Contract and a complete set of Drawings and Specifications in PDF format.
- b. The Owner will furnish explanatory and changed Drawings to the Contractor in PDF format

as issued during project.

- c. The Owner will provide electronic data files to the Contractor for their convenience and use in progressing the Work and the preparation of shop drawings or other submittal requirements required for construction of the reference project. The electronic data files shall reflect Construction Documents and Bid Addenda only. These files will be transmitted subject to the following terms and conditions:
- (1) The Owner makes no representation as to the compatibility of these files with the Contractor's hardware or software.
 - (2) Data contained on these electronic files shall not be used by the Contractor or anyone else for any purpose other than as a convenience in progressing the Work or in the preparation of shop drawings or other required submittals for the referenced project. Any other use or reuse by the Contractor or by others will be at their own sole risk and without liability or legal exposure to Owner. The Contractor agrees to make no claim and hereby waive, to the fullest extent permitted by law, any claim or cause of action of any nature against the Owner and its consultants, contractors, agents, employees, and representatives that may arise out of or in connection with the use of the electronic files transmitted.
 - (3) Furthermore, the Contractor shall, to the fullest extent permitted by law, indemnify and hold harmless the Owner and its consultants, contractors, agents, employees, and representatives, against all damages, liabilities or costs, including reasonable attorney's fees and defense costs, arising out of or resulting from the use of these electronic files.
 - (4) These electronic files are not contract documents. Differences may exist between these electronic files and corresponding hard-copy construction documents. The Owner makes no representation regarding the accuracy or completeness of the electronic files you receive. In the event that a conflict arises between the signed or sealed hard-copy construction documents prepared by the Consultant and the electronic files, the signed and sealed hard-copy construction documents shall govern. The Contractor is responsible for determining if any conflict exists. By use of these electronic files, the Contractor is not relieved of their duty to fully comply with the contract documents.
 - (5) Because information presented on the electronic files can be modified, unintentionally or otherwise, the Owner reserves the right to remove all indications of ownership and/or involvement from each electronic display.
 - (6) Under no circumstances shall delivery of the electronic files be deemed a sale by the Owner and no warranties are made, either expressed or implied, of merchantability and fitness for any particular purpose. In no event shall the Owner be liable for any loss of profit, or any consequential damages as a result of use or reuse of these electronic files.

6. SUBMITTALS

- a. The Contractor shall submit for approval to the Architect, equipment lists and Shop Drawings as expediently as possible. Failure of the Contractor to submit Shop Drawings in a timely manner will result in the Owner holding back Contractor payments. (See General Conditions)
- b. The material and equipment lists shall be submitted and approved before any material or equipment is purchased and shall be corrected to as-built conditions before the completion of the project.
- c. The Contractor shall submit electronic versions of all required Shop Drawings, material and equipment lists. The Contractor shall upload all Shop Drawings to a secure information sharing website determined by the Owner notifying the Owner and Consultant that these shop drawings are available for review. Each submittal shall have the General Contractors digital stamp affixed to the first page signifying their review and acceptance. Review comments, approvals, and rejections will be posted on this same site with notification to the contractor. Submittals requiring a professional seal shall be submitted hard copy with a manual seal affixed.
 - (1) The Contractor shall identify each submittal item with the following:
 - (a) Project Title and Locations
 - (b) Project Number
 - (c) Supplier's Name
 - (d) Manufacturer's Name
 - (e) Contract Specification Section and Article Number
 - (f) Contract Drawing Number
 - (g) Acrobat File Name: Spec Section_Times Submitted_Spec Title:
033000_01-Cast in Place Concrete.pdf
 - (2) Reference the accompanying Shop Drawing and Submittal Log at the end of this section (1.E.4) for the required submittal information.
- d. The Contractor shall submit to the Architect four (4) bound copies of all required Operating Instructions and Service Manuals for the Architect's and the Owner's sole use prior to completing 50% of the adjusted contract. Payments beyond 50% of the contract amount may be withheld until all Operating Instructions and Service Manuals are received as referenced in the accompanying Operating Instructions and Service Manual Log at the end of this section (1.E.5).
- e. The Contractor shall submit to the Owner's Representative all items referenced in the accompanying Closeout Log (1.E.6) within 30 days following substantial completion of the work. The Owner's Representative will maintain the closeout log and include as an agenda item at all coordination meetings.

7. USE OF PREMISES

- a. Access: Access to construction site shall be as indicated on the drawings and as directed by

the Owner's Representative.

b. Parking:

- (1) Parking of Contractor service vehicles within project access/lay down/staging areas is allowed. Employee parking shall be on public streets or where directed by the Owner's Representative. The contractor parking lot (if available), may also be utilized for employee parking.
- (2) Parking or driving on sidewalks, landscaped areas, within fire and service lanes or generally in areas not designated for vehicular traffic is prohibited except as allowed in the contract documents. Violation of this requirement may result in ticketing and/or towing at the vehicle owner's expense and suspension of progress payments.
- (3) Sidewalk(s) and Hardscape – Parking/driving on hardscapes is strictly prohibited unless specifically directed by the Owner's Representative through the MU sidewalk permitting process. Restricted use permits will be limited to activities that are constrained by an absolute need to access from a sidewalk. Such activities shall be considered the exception and not the norm. Adequate signage, fencing and alternate routes must be provided in the immediate and adjacent areas.
- (4) Free parking for contractor employees is available in the Ashland Road Contractor lot on an as-available basis. This space is for use by contractor employees for parking their personal vehicles only and is not to be used for staging or storage.
- (5) Vendor Permits may be purchased by contractor management personnel on an as available basis by contacting the Parking and Transportation office in the General Services Building. These permits will allow contractor management personnel to park in various University lots while conducting business on University construction projects.
- (6) Temporary University parking permits may be purchased by contractor employees for use with their personal vehicles on an as available basis by contacting the Parking and Transportation office in the General Services Building.
- (7) Conley Avenue between Missouri Avenue and University Avenue and Hitt Street between University Avenue and the Memorial Union are designated for pedestrian use only during the work week between the hours of 8:15 AM and 3:45 PM. Unless otherwise indicated in the contract documents, this area is strictly off limits to vehicular traffic without authorization from the Owner's Representative.

- c. Storage of materials: The Contractor shall store all materials within project limits. The Contractor shall confine apparatus, materials, and operation of workers to location established by the Owner's Representative. The Contractor shall not unreasonably encumber premises with materials. In addition, storage trailer locations may be available within 1-1/2 miles of project site as directed by the Owner's Representative. Storage trailer locations shall be subject to approval by the Owner's Representative and are available to the

Contractor without cost.

- d. Utilities: Drinking water, water required to carry on work, and 120-volt electrical power required for small tool operation may be obtained without cost to the Contractor from existing utilities at locations designated by the Owner's Representative. Provisions for obtaining power, including temporary extensions, shall be furnished, and maintained by the Contractor. Upon completion of work such extensions shall be removed and any damage caused by use of such extensions shall be repaired to the satisfaction of the Owner's Representative, at no cost to the Owner.
- e. Restroom: Existing toilet facilities within Project Limits or Restrooms designated by the Owner's Representative for use by the Contractor will be available. Failure of the Contractor to maintain restrooms in a clean condition will be cause for the Contractor's discontinued use of the restroom.
- e. Smoking is prohibited at the University of Missouri and all properties owned, operated, leased or controlled by the University of Missouri. Violation of the policy is defined as the use of any tobacco or marijuana products, including e-cigarettes, cigarettes, and vaping.
- f. Care of Project Work Site: The contractor shall be responsible for maintaining the construction site in a reasonably neat and orderly condition by regular cleaning and mowing of the premises as determined by the Owner's Representative.
- g. Discharge to Sewer Request: The University of Missouri's MS4 permit and NPDES Storm Water Discharge Permits along with the City of Columbia's POTW Operating Permit as well as local ordinances, and state and federal environmental regulations prohibit hazardous materials from being disposed into either the storm water or sanitary sewer systems. Unless specifically approved, all chemical products such as paints, dyes, lawn care products, maintenance products, and oil are prohibited from drain disposal. Any product, including contaminated water, being discarded into the storm water or sanitary sewer systems requires written approval from the Owner through a formal "Discharge to Sewer Request" form obtained a. The contractor should submit the form to the Owner's Representative, not to the Department of Environmental Health and Safety as the form indicates.
- h. All concrete waste material including washout water shall be totally contained and removed from the Owner's property.
- i. Artifacts Found During Construction: Contractor shall immediately notify the Owner's Representative when artifacts are uncovered or found during the demolition or construction process. Artifacts include, but are not limited to, tools, drawings (construction or other), photographs, books and other objects/devices which may hold historical importance/significance. Do not remove or disturb the object(s) in question. Artifacts are not considered part of demolished materials and shall remain the property of the University of Missouri.

9. PROTECTION OF OWNER'S PROPERTY

- a. The Contractor shall be responsible for repair of damage to building exterior and interior, drives, curbs, streets, walks, grass, shrubbery and trees, which was caused by workmen or equipment employed during progress of work. All such repairs shall be made to the satisfaction of the Owner's Representative, at no cost to the Owner, or reimburse the Owner if the Owner elects to make repairs. For landscape damage, the Owners shall make such repairs. Compensation for these repairs shall be determined by the Owner's Representative using the "Valuation of Landscape Trees, Shrubs, and other Plants" as published by the International Society of Arboriculture, as last revised.
- b. Construction Project Fencing:
 - (1) Fencing requirements, as indicated on Drawings, shall be constructed of 9 or 11-gauge chain link not less than six (6) feet in height and not more than 2-inch mesh with posts spaced not more than ten (10) feet apart and all corner and gate posts imbedded in concrete. All other posts shall be sufficiently secured in ground to maintain proper and adequate support of fence. Fenced in area shall have at least two (2) access gates and all gates shall be lockable.
 - (2) Using existing landmarks, lamp posts, trees or other Owner property for support of fencing is strictly prohibited unless a written waiver is obtained from Owner's Representative.
 - (3) Use of ribbon, snow fence, chicken wire, rope, and wooden barricades as fencing is prohibited.
 - (4) Fencing shall be maintained in an "as-installed" condition throughout the life of the project.
 - (5) The Contractor may use used fencing provided it is in good condition and is satisfactory to the Owner's Representative.
- c. Preserving and Protecting Existing Vegetation:
 - (1) Protection and compensation for damages:
 - (a) Trees and shrubs within work area designated to remain shall be protected from damage during construction by fixed chain link fencing or armoring as indicated on Drawings or specified herein. Plant protection devices shall be installed before work has begun and shall be maintained for duration of work unless otherwise directed by Owner's Representative.
 - (b) In the event that damage(s) to the Owner's trees, shrubs or vegetation occurs as a result of the Contractor's unauthorized operations, the Contractor shall pay or allow to the Owner compensation for said damage(s). Compensation shall be determined by the Owner's Representative using the "Valuation of Landscape Trees, Shrubs, and other

Plants" as published by the International Society of Arboriculture, as last revised.

- (2) Plants within work area designated for removal shall be removed by Contractor.
- (3) To prevent compaction of soil over tree roots, vehicles or equipment shall not at any time park or travel over, nor shall any materials be stored within drip line of trees designated to remain.
- (4) Owner's Representative will stop work immediately when proper measures are not being employed to protect trees and shrubs. Contractor will be notified to resume work after required protection measures are implemented.
- (5) Removal and/or pruning of select landscape materials shall be performed by MU Landscape Services department.
- (6) Pruning of limbs necessary to repair damage or provide clearance for work shall be performed by approved, trained tree maintenance personnel. Limbs shall be cut off cleanly and cut surfaces treated according to established horticultural standards.

10. SUBSTITUTIONS AND EQUALS

- a. Substitutions and equals are defined in Article 3 of the General Conditions.
- b. Use of materials, products or equipment other than those named and described in the Contract Documents are substitutions and/or equal. Substitutions and/or equals of any item described in the Contract Documents will be allowed only prior to the receipt of bids provided that a request for approval has been received by both the Architect and the Owner at least ten calendar days prior to the date for receipt of Bids. To be considered, bidder's proposal shall include a complete description of the proposed substitution and/or equal and a comparison of significant qualities of the proposed substitution and/or equal with those specified including drawings, performance and test data, and other information necessary for an evaluation. The Architect's decision on the approval or disapproval of a proposed substitution and/or equal shall be final. If the Architect and Owner approve a proposed substitution prior to receipt of Bids, such approval will be set forth in an Addendum. Bidders shall not rely upon approval made in any other manner.

11. CODES AND STANDARDS

- a. The Contractor shall comply with applicable codes and standards as listed in the General Conditions.

12. PERMITS

- a. The Owner will secure and pay for specific necessary approvals, easements, assessments, and charges required for construction, use or occupancy of permanent structures, or for permanent changes in existing facilities except as noted in Article 3.2 of the General Conditions.

13. PRE-BID INSPECTION

- a. All pre-bid inspections of work areas shall be scheduled with pre-bid inspection guide, telephone: (573) 882-6800

14. MODIFICATIONS TO INFORMATION TO BIDDERS

- a. Information to Bidders:
(1) Referenced Information to Bidders, Page IFB/5.
Add new Article 15.8.5 as follows:

15.8.5 Within 48 hours of the receipt of bids, the apparent low bidder shall submit to the Director of Facilities Planning and Development an "Affidavit of Supplier Diversity Participation" for every diverse subcontractor or supplier the bidder intends to award work to on the contract. The affidavit will be signed by both the bidder and the diverse firm.

16. MODIFICATION TO INFORMATION FOR BIDDERS: BIDDERS STATEMENT OF QUALIFICATIONS

- a. Information For Bidders
(1) Reference: Information for Bidders, Article 8.4

Add new Article 8.4 to read as follows:

In addition to the Bidder's Statement of Qualifications, the Bidder must also submit evidence and meet the following qualifications:

(a) MINIMUM QUALIFICATIONS

- (i) Successful completion of three projects of similar type and scope in fully occupied building.
- (ii) Successful and sustained track record of effectively utilizing project/schedule management software on renovation projects in fully occupied building.

(b) QUALIFICATION SUBMITTALS

- (i) Submitted qualification packages should include the following information:
 - Project and Schedule
 - Management Experience managing project with equal or greater schedule demands.
 - Demonstrated and consistent on-time completion

success

- Project Organization / Personnel
 - Key project team members and their resume
 - Project team roles and responsibilities of team members
 - Reporting/accountability procedures
 - Quality control program and procedures
- Organizational Support
 - Home office support
 - Labor and subcontractor relations
 - Submittal processing procedures
 - Material ordering/tracking/delivery procedures
 - Cost accounting support
 - Financial stability/capacity
 - Record of mentoring and supporting Supplier Diversity Subcontractor Participation

(ii) Packages must include the following items:

- Corporate Organizational Charts
- Project Organizational Charts
- Summary of Similar Projects
- Client References
- Resumes – resumes for each key individual proposed for the project, include position in the firm, project responsibility, education, license or registration and relevant experience over the last five years.
- Financial Statements and/or Evidence of Bonding Capacity
- Sample progress reports and schedules
- Brief narratives indicating how the Contractor intends to manage this project, including subcontractors.

(c) QUALIFICATION PROCEDURE

(i) All qualification information and supporting materials must be submitted with your bid. Following the bid date, the Owner reserves the right to request additional information material to evaluate qualifications. Failure of the Contractor to demonstrate their ability to comply with these qualifications may be grounds for the Owner not recommending award of the Contract.

17. PROJECT SCHEDULING

- a. Contractor Schedule – Contractor is responsible for the schedule, that may be provided with in-house personnel or hired a third-party scheduling consultant. See Contractor Schedule Requirements included in these documents.

b. Contractor Schedule Requirements

(1) GENERAL

- (a) Time is of the essence for this contract. The time frames spelled out in this contract are essential to the success of this project. The University understands that effective schedule management, in accordance with the General Conditions and these Special Conditions is necessary to insure to that the critical milestone and end dates spelled out in the contract are achieved.
- (b) Related Documents
 - (i) Drawings and general provisions of the Contract, including General Conditions' Article 3.18 shall apply to this Section.
- (c) Stakeholders
 - (i) A Stake holder is anyone with a stake in the outcome of the Project, including the University, the University Department utilizing the facility, the Design Professionals, the Contractor and Subcontractor(s).
- (d) Weather
 - (i) Contractor acknowledges that there will be days in which work cannot be completed on weather sensitive activities, due to the weather, and that a certain number of these lost days are to be expected under normal weather conditions in Missouri.
 - (ii) Rather than speculate as to what comprises "normal" weather at the location of the project, Contractor agrees that it will assume a total of 44 lost days, on weather sensitive activities of critical path work, due to weather over the course of a calendar year and include same in its as planned schedule. For projects of less than a calendar year, lost weather days should be prorated for the months of construction in accordance with the following schedule.
 - (iii) Anticipated weather days for allocation/proration only. For projects lasting 12 months or longer, the 44 days per year plus whatever additional months are included will constitute normal weather.

Jan – 5 days	Feb – 5 days	Mar – 4 days	Apr – 4 days
May – 3 days	Jun – 3 days	Jul – 2 days	Aug – 2 days
Sep – 3 days	Oct – 4 days	Nov – 4 days	Dec – 5 days

- (iv) The Contractor shall notify the Owner's Representative via email on the same day a lost weather day occurs and shall maintain a log of weather days to be included in the Narrative described in 2.3.4 herein.

(2) SCHEDULING PROCESS

- (a) The intent of this section is to ensure that a well-conceived plan, that addresses the milestone and completion dates spelled out in these documents, is developed with input from all stakeholders in the project. Input is limited to all reasonable requests that are consistent with the requirements of the contract documents, and do not prejudice the Contractor's ability to perform its work consistent with the contract documents. Further, the plan must be documented in an understandable format that allows for each stakeholder in the project to understand the plan for the construction and/or renovation contained in the Project.

- (b) Contractor Requirements

- (i) Schedule Development

Contractor shall prepare the Project Schedule using the latest version of Phoenix Project Management scheduling software or other software as approved by the Owner's Representative prior to receipt of bids.

Contractor shall review each major subcontractor's schedule with the sub and obtain the subcontractor's concurrence with the schedule, prior to submitting to the University.

- (ii) Schedule Updates

1. Schedule Updates will be conducted once a month, at a minimum. Actual Start and Finish dates should be recorded regularly during the month. Remaining Duration shall be updated as of the data date, just prior to Contractor's submittal of the updated data.
2. Contractor will copy the previous months schedule and will input update information into the new monthly update version.
3. Contractor will meet with the Owner's Representative to review the draft of the updated schedule. At this meeting, Owner's Representative and Contractor will:

- (a) Review out of sequence progress, making adjustments as necessary.
 - (b) Add any fragnets necessary to describe changes or other impacts to the project schedule and
 - (c) Review the resultant critical and near critical paths to determine any impact of the occurrences encountered over the last month.
- (b) Schedule Narrative

After finalization of the update, the Contractor will prepare a Narrative that describes progress for the month, impacts to the schedule and an assessment as to the Contractor's entitlement to a time extension for occurrences beyond its control during the month and submit in accordance with this Section.
- (c) Progress Meetings
 - (i) Review the updated schedule at each monthly progress meeting. Payments to the Contractor may be suspended if the progress schedule is not adequately updated to reflect actual conditions.
 - (ii) Submit progress schedules to subcontractors to permit coordinating their progress schedules to the general construction work. Include four (4) weeks look ahead schedules to allow subs to focus on critical upcoming work.

(3) CRITICAL PATH METHOD (CPM)

- (a) This Section includes administrative and procedural requirements for the critical pay method (CPM) of scheduling and reporting progress of the Work.
- (b) Refer to the General and Special Conditions and the Agreement for definitions and specific dates of Contract Time.
- (c) Critical Path Method (CPM): A method of planning and scheduling a construction project where activities are arranged based on activity relationships and network calculations determine when activities can be performed and the critical path of the Project.
- (d) Critical Path: The longest continuous chain of activities through the network schedule that establishes the minimum overall project duration.
- (e) Network Diagram: A graphic diagram of a network schedule, showing the activities and activity relationships.

- (f) Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling, the construction project. Activities included in a construction schedule consume time and resources.
- (g) Critical activities are activities on the critical path.
- (h) Predecessor activity is an activity that must be completed before a given activity can be started.
- (i) Milestone: A key or critical point in time for reference or measurement.
- (j) Float or Slack Time: The measure of leeway in activity performance. Accumulative float time is not for the exclusive use or benefit of the Owner or Contractor but is a project resource available to both parties as needed to meet contract milestones and the completion date.
- (k) Total float is herein defined as the measure of leeway in starting or completing an activity without adversely affecting the planned project completion date.
- (l) Weather: Adverse weather that is normal for the area must be taken into account in the Contractor's Project Schedule. See 1.(d)(iii), above.
- (m) Force Majeure Event: Any event that delays the project but is beyond the control and/or contractual responsibility of either party.
- (n) Schedule shall include the following, in addition to Contractor's work.
 - (i) Phasing: Provide activity codes in the schedule to show how the sequence of the Work is affected by the following:
 1. Requirements for phased completion and milestone dates.
 2. Work by separate contractors.
 3. Work by the Owner
 4. Coordination with existing construction.
 5. Limitations of continued occupancies.
 6. Uninterruptible services.
 7. Partial occupancy prior to Substantial Completion.
 8. Area Separations: Use Activity Codes to identify each major area of construction for each major portion of the Work. For the purposed of the Article, a "major area" is a story of construction, a separate building, or a similar significant construction element.
 9. Required delivery dates for Owner furnished equipment, if applicable
 10. Post substantial completion activities and closeout
 11. Floor or Level: Use separate activity codes to identify each floor or level.

12. Subcontractor: Use Activity Codes to identify each subcontractor's work activities.
13. Type Work or Craft: Use Activity Codes to identify the type of work, or craft that will execute each activity.

(4) TIME EXTENSION REQUEST

- (a) Refer to General Conditions of the Contract for Construction, Article 4.7 Claims for Additional Time.
- (b) Changes or Other Impacts to the Contractor's Work Plan. The Owner will consider and evaluate requests for time extensions due to changes or other events beyond the control of the Contractor on a monthly basis only, with the submission of the Contractor's updated schedule, in conjunction with the monthly application for payment. The Update must include:
 - (i) An activity depicting the event(s) impacting the Contractors work plan shall be added to the CPM schedule, using the actual start date of the impact, along with actually required predecessors and successors.
 - (ii) After the addition of the impact activity(ies), the Contractor will identify subsequent activities on the critical path, with finish to start relationships that can be realistically adjusted to overlap using good, standard construction practice.
 1. If the adjustments above result in a completion date beyond the contract completion date, the delay shall be deemed excusable, and the contract completion date shall be extended by the number of days indicated by the analysis.
 2. Contractor agrees to continue to utilize its best efforts to make up the time caused by the delays. However, the Contractor is not expected to expend costs not contemplated in its contract, in making those efforts.
- (c) Questions of compensability of any delays shall be held until the actual completion of the project. If the actual substantial completion date of the project based on excusable delays, excluding allocated weather delays, exceeds the original contract completion date, AND there are no delays that are the responsibility of the contractor to consider, the delays days may be considered for equitable adjustment. In review of time extension requests for compensable days, the Owner will consider the actual number of weather days incurred.
- (d) Home office expenditures and staff are NOT compensable.

18. PROJECT COORDINATION

- a. Coordinate construction operations included in various Sections of these Specifications to assure efficient and orderly installation of each part of the Work. Coordinate construction operations.
 - (1) Schedule construction operations in the sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - (2) Coordinate installation of different components to assure maximum accessibility for required maintenance, service, and repair.
 - (3) Make provisions to accommodate items scheduled for later installation.
- b. Coordination Drawings: Within thirty (30) days of Notice to Proceed provide coordination drawings for the integration of the Work, including work first shown in detail on shop drawings or product data. Show sequencing and relationship of separate units of work which must interface in a restricted manner to fit in the space provided, or function as indicated.
 - (1) Show the interrelationship of components shown on separate shop drawings.
 - (2) Indicate required installation sequences.
 - (3) Call attention in advance to Architect of any dimensional or detail information needed to complete the coordination drawings.

19. MECHANICAL, ELECTRICAL, PLUMBING (MEP) PRE-INSTALLATION MEETING(S)

- a. Before the start of MEP installation, the Owner's Representative will convene an MEP pre-installation meeting. Meeting participants to include contractor (including MEP subcontractors), Owner's Representative and additional contractor and University operational staff invited by the Owner's Representative. Topics will include underground rough-ins, steam piping, chilled water piping, sprinkler piping, hot water piping, electrical system, duct, telephone/data wiring, control wiring. Additional meetings will be conducted as required for the review of coordination drawings and scope specific installations. Cross section drawings of corridor ceilings and other congested areas will be of highest priority and will be reviewed prior to the start of installations in the affected areas. Meeting minutes and sign-up sheet will be transcribed by contractor and distributed to attendees.
- b. Per article 3.14.4 of the General Conditions, coordination drawings are required prior to beginning MEP work. These drawings shall be reviewed and approved by the Consultant and the Owner's Representative.
- c. Per article 3.14.4 of the General Conditions, BIM drawings, in a format approved by the Owner's Representative, are required prior to beginning work and shall be updated to include as-built conditions. These BIM model(s) shall be reviewed collectively in a meeting with the Contractor, MEP subcontractor(s), Consultant, Owner's Representative, and other Owner

staff. Additional review meetings shall be required as requested by the Owner's Representative until the BIM drawings are officially approved for construction.

- d. All serviceability clearances stated in manufacturer's equipment/product data shall be strictly provided.

20. COST BREAKOUT FOR OWNER'S ACCOUNTING PURPOSES / SPEND DOWN PURPOSES

- a. If requested by the Owner's Representative, Contractor shall submit anticipated monthly spend downs which are estimates of all future monthly billings for the remainder of the project.

21. PROJECT MANAGEMENT/COMMUNICATION REQUIREMENTS

- a. The Contractor shall be represented at the site by a full-time, competent superintendent with no other assigned duties or responsibilities from the beginning of the work until its final acceptance, unless otherwise permitted by the Owner's Representative. The superintendent for the Contractor for the general building work shall exercise general supervision over all subcontractors of any tier engaged on the work with decision-making authority of the Contractor.
- b. The Contractor shall furnish on-site Internet access for use by his Project Manager and superintendent. The contractor shall utilize the Owner's secure information sharing system for submittals, construction payment process, change orders, RFI's/ASI's, O&M manuals and all other project manual requirements as directed by the Owner's Representative. Field staff are also required to utilize this software as directed by the Owner's Representative.
- c. The Contractor shall provide mobile technology/ telephone for use by the on-site superintendent to facilitate communication with the Owner's Representative.

22. SAFETY PRECAUTIONS AND PROGRAMS

- a. The Bidder's Statement of Qualifications includes a requirement that the Bidder provide its Worker's Compensation Experience Modification Rates (EMR) and Incidence Rates for the three recent years. The Bidder shall also include the EMR and Incidence Rates of listed major subcontractors on the Bid for Lump Sum Contract. If the EMR exceeds 1 or the Incidence Rate exceeds 13, the Contractor or major subcontractor shall take additional safety measures including, but not limited to, developing a site-specific safety plan and assigning a Safety Manager to the Project to perform inspections on a schedule as determined acceptable by the Owner with written reports to be submitted to the Owner. The Owner reserves the right to reject a Bidder or major subcontractor whose rates exceed these stated rates.
- b. The contractor shall provide Emergency Contact Information for the Contractor's on-site staff and home office management as well as contact information for all major subcontractor personnel. This information shall contain business and personal phone numbers for each individual for contact during or after hours in case of an emergency. This information shall be

submitted within 15 days of the Notice to Proceed.

23. HOT WORK PERMITTING AND GENERAL REQUIREMENTS

- a. Hot work Requirements: The contractor shall comply with the following hot work requirements and the requirements of the International Fire Code and NFPA 51B.
 - (1) Hot work shall be defined as any work involving burning, welding, grinding, cutting, or similar operations that are capable of producing sparks, initiating fires or explosions.
 - (2) The Contractor shall utilize the hot work permit decision tree and procedures as outlined in NFPA 51B for all Hot Work operations.
 - (3) The University of Missouri Hot Work Permit (see Appendix 1.I) shall be used on all hot work performed outside a designated hot work area. The University of Missouri hot work permit shall be posted and clearly visible within proximity of the hot work area. The hot work permit authorizing individual (PAI) shall be as designated by the Contractor.
 - (4) Notify the Owner's Representative 24 hours prior to starting hot work in buildings with operational fire alarm or fire suppression systems. The Owner's Representative will coordinate the appropriate system outage with Campus Maintenance personnel.
 - (5) Unless otherwise instructed by the Owner's Representative, the Contractor shall post a copy of each completed hot work permit to the Owner's project management file system the following business day.
 - (6) Hot Work personnel shall consist of the following three roles: the Permit Authorizing Individual (PAI), the Hot Work Operator (person doing the work), and the Fire Watch personnel. Hot Work Operators shall not be utilized to perform Fire Watch duties. Fire watch and monitoring duration shall be as required on the University of Missouri hot work permit.

24. GENERAL REQUIREMENTS FOR CRANE AND HOISTING OPERATIONS

- a. All crane and hoisting operations shall be performed in compliance with OSHA 29 CFR 1926. All Operators, riggers, and signal persons must have the proper qualifications and training necessary to perform the intended hoisting activities for this project.
- b. Only fully certified and evaluated Operators shall perform equipment operations. Operators in an "Operator in Training" status shall not be used.
- c. Submittal requirements:
 - (1) Submit copies of Operator certifications, licenses, and evaluations to the Owner's Representative. Submit Rigger and Signal Person qualifications to the Owner's

Representative.

- (2) Unless otherwise directed by the Owners Representative, submit a lift plan and conduct a lift coordination meeting for hoisting or crane operations for any lift greater than 2,000 pounds, or for any multi pick lift. Include protective measures for existing underground utilities, occupied buildings, pedestrian and vehicle pathways, adjacent buildings and overhead power lines. If the lift is to occur over an occupied building, provide a registered structural engineer's review and verification that the building can resist the impact of a dropped load for the intended lift. If evacuation of an occupied building is necessary to conduct the lift, the decision for building evacuation or scheduling the lift for off-hours will be determined by the Owner.

25. CONSTRUCTION WASTE MANAGEMENT

- a. The goal of Construction Waste Management is to divert waste from the sanitary landfill. This shall be accomplished through reuse, recycling and/or salvage of non-hazardous construction and demolition debris to the greatest extent practical. Track and report all efforts related to reuse, recycling and/or salvage materials from the project (including clean fill material). Report all material types and weights, where material was diverted, type of diversion, documentation of diversion (waste or recycling tickets), and applicable dates. In order to calculate the diversion percentage, total weights of all non-hazardous landfill material must be reported. This information shall be updated monthly utilizing the [Construction Waste Management Worksheet](#). Copies of all applicable receipts, tickets and tracking logs shall be uploaded to the Owner's information sharing website or reported as required by the Construction Project Manager.
- b. A summary worksheet is required prior to substantial completion.

26. WARRANTY WALKTHROUGH

- a. Contractor shall attend a walk-thru with the Owner at eleven (11) months after acceptance to review and document any warranty items to be addressed as part of the twelve (12) month warranty stated in article 3.1 of the General Conditions.

END OF SECTION

SECTION 1.E.3
SHOP DRAWING SUBMITTAL LOG

Section	Description	Contractor	Date Rec'd	#	Date Sent to Cons.	Date Ret'd	Remarks	Date Ret'd	Contractor	Owner	File
024119	Proposed Protection Measures										
024119	Selective Demolition Schedule										
024119	Predemolition Photographs and/or Video										
033000	Material Certificates										
033000	Material Test Reports										
033000	Formwork Shop Drawings										
033511	Product Data										
033511	Maintenance Data										
042200	Product Data										
042200	Mix Designs										
055000	Shop Drawings										
055000	Welding Certificates										
061053	Product Data										
061053	Evaluation Reports										
064116	Product Data - For Each Product										
064116	Shop Drawings										
064116	Samples for Each Product										
064116	Qualification Data										
064116	Product Certificates										
070150	Product Data - For Each Product										
070150	Qualification Data										
072100	Product Data - For Each Product										
072100	Product Test Reports										
078413	Product Data										
078413	Product Schedule										
078413	Qualification Data - Installer										
078413	Installer Certificates										
078413	Product Test Reports										
079200	Product Data - Each Joint-Sealant										
079200	Joint-Sealant Schedule										
079200	Qualification Data - Installer										
079200	Product Certificates										
079200	Product Test Reports										
081113	Product Data - For Each Product										

SECTION 1.E.3
SHOP DRAWING SUBMITTAL LOG

Section	Description	Contractor	Date Rec'd	#	Date Sent to Cons.	Date Ret'd	Remarks	Date Ret'd	Contractor	Owner	File
081113	Shop Drawings										
081113	Product Schedule										
081113	Product Test Reports										
081416	Product Data										
081416	Shop Drawings										
081416	Sample										
083113	Product Data										
083113	Shop Drawings										
087100	Product Data										
087100	Door Hardware Schedule										
088000	Product Data										
088000	Samples										
088000	Glazing Schedule										
088000	Product Certificates										
088000	Product Test Reports										
092116	Product Data										
092116	Evaluation reports										
092216	Product Data - For Each Product										
092900	Product Data - For Each Product										
093013	Product Data - For Each Product										
093013	Samples for Verification										
095113	Product Data - For Each Product										
095113	Samples for Verification										
096513	Product Data - For Each Product										
096513	Samples for Verification										
096519	Product Data - For Each Product										
096519	Shop Drawings										
096519	Samples for Verification										
096519	Qualification Data - Installer										
096723	Product Data - For Each Product										
096723	Samples for Each Product										
096723	Qualification Data - Installer										
096813	Product Data - For Each Product										
096813	Shop Drawings										
096813	Samples										
099113	Product Data										

SECTION 1.E.3
SHOP DRAWING SUBMITTAL LOG

Section	Description	Contractor	Date Rec'd	#	Date Sent to Cons.	Date Ret'd	Remarks	Date Ret'd	Contractor	Owner	File
099113	Samples										
099113	Product Schedule										
101100	Product Data										
101100	Shop Drawings										
101100	Samples										
101400	Product Data										
101400	Shop Drawings										
101400	Samples										
102113	Product Data										
102113	Shop Drawings										
102113	Samples										
102600	Product Data										
102600	Samples										
102800	Product Data										
102800	Samples for Verification										
104413	Product Data - For Each Product										
104413	Product Shop Drawings										
104416	Product Data - For Each Type of Product										
115300	Product Data - For Each Type of Product										
115300	Product Certificates										
115313	Product Data										
115313	Shop Drawings										
122413	Product Data - For Each Product										
122413	Shop Drawings										
122413	Samples for Verification										
123553	Product Data - For Each Product										
123553	Shop Drawings										
123553	Samples for Verification										
123553	Qualification Data - Installer										
123661	Product Data										
123661	Shop Drawings										
123661	Samples										
210500	Product Data										
210500	Shop Drawings										
210500	Delegated Design Submittal										
210553	Product Data										

SECTION 1.E.3
SHOP DRAWING SUBMITTAL LOG

Section	Description	Contractor	Date Rec'd	#	Date Sent to Cons.	Date Ret'd	Remarks	Date Ret'd	Contractor	Owner	File
211000	Product Data										
211000	Shop Drawings										
211000	Delegated Design Submittal										
211000	Test Reports										
211000	Certificates										
220500	Product Data										
220500	Shop Drawings										
220500	Delegated Design Submittal										
220523	Product Data - For Each Product										
220529	Product Data - For Each Product										
220529	Shop Drawings										
220529	Welding Certificates										
220700	Product Data - For Each Product										
221116	Product Data - For Each Product										
221119	Product Data - For Each Product										
221119	Shop Drawings										
221316	Product Data - For Each Product										
221319	Product Data - For Each Product										
224300	Product Data - For Each Product										
224300	Shop Drawings										
226113	Product Data - For Each Product										
226113	Welding Certificates										
226213	Product Data - For Each Product										
226213	Welding Certificates										
226700	Product Data - For Each Product										
226800	Product Data										
226800	Shop Drawings										
226800	Delegated Design Submittal										
226800	Welding Certificates										
230500	Product Data										
230500	Shop Drawings										
230500	Delegated Design Submittal										
230513	Product Data										
230519	Product Data										
230523	Product Data										
230529	Product Data										

SECTION 1.E.3
SHOP DRAWING SUBMITTAL LOG

Section	Description	Contractor	Date Rec'd	#	Date Sent to Cons.	Date Ret'd	Remarks	Date Ret'd	Contractor	Owner	File
230529	Shop Drawings										
230529	Qualification Data - Installer										
230540	Product Data										
230700	Product Data - For Each Product										
230700	Shop Drawings										
230700	Samples										
230700	Qualification Data - Installer										
230900	Product Data - For Each Product										
230900	Shop Drawings										
232113	Product Data - For Each Product										
232113	Shop Drawings										
232113	Qualification Data - Installer										
233113	Product Data - For Each Product										
233113	Shop Drawings										
233113	Test Reports										
233113	Welding Certificates										
233300	Product Data - For Each Product										
233419	Product Data - For Each Product										
233419	Shop Drawings										
233419	Test Reports										
233423	Product Data - For Each Product										
233423	Shop Drawings										
233423	Test Reports										
233600	Product Data - For Each Product										
233600	Shop Drawings										
233600	Test Reports										
233713	Product Data - For Each Product										
233713	Samples										
237313	Product Data - For Each Product										
237313	Shop Drawings										
237313	Test Reports										
238216	Product Data - For Each Product										
260519	Product Data - For Each Product										
260519	Qualification Data - Installer										
260519	Test Reports										
260526	Product Data - For Each Product										

SECTION 1.E.3
SHOP DRAWING SUBMITTAL LOG

Section	Description	Contractor	Date Rec'd	#	Date Sent to Cons.	Date Ret'd	Remarks	Date Ret'd	Contractor	Owner	File
260526	Test Reports										
260529	Product Data										
260529	Shop Drawings										
260529	Delegated Design Submittal										
260529	Test Reports										
260533	Product Data										
260533	Shop Drawings										
260536	Product Data										
260536	Shop Drawings										
260536	Delegated Design Submittal										
260536	Test Reports										
260544	Product Data										
260548.16	Product Data - For Each Product										
260548.16	Shop Drawings										
260548.16	Qualification Data - Installer										
260553	Product Data										
260553	Delegated Design Submittal										
260572	Product Data										
260572	Qualification Data - Installer										
260573	Product Data										
260573	Qualification Data - Installer										
260574	Product Data										
260574	Qualification Data - Installer										
260923	Product Data - For Each Product										
260923	Shop Drawings										
262200	Product Data - For Each Product										
262200	Shop Drawings										
262200	Qualification Data										
262416	Product Data - For Each Product										
262416	Shop Drawings										
262416	Qualification Data										
262726	Product Data - For Each Product										
262726	Shop Drawings										
262726	Test Reports										
262813	Product Data - For Each Product										
262816	Product Data - For Each Product										

Project: Medical Science Building 7E Renovation
 Project Number: CP2400920
 Contractor:

SECTION 1.E.3
SHOP DRAWING SUBMITTAL LOG

Section	Description	Contractor	Date Rec'd	#	Date Sent to Cons.	Date Ret'd	Remarks	Date Ret'd	Contractor	Owner	File
262816	Shop Drawings										
262816	Qualification Data										
262816	Test Reports										
262923	Product Data - For Each Product										
262923	Shop Drawings										
262923	Qualification Data										
262923	Test Reports										
265119	Product Data - For Each Product										
265119	Shop Drawings										
265119	Qualification Data										
265119	Test Reports										
265219	Product Data - For Each Product										
265219	Shop Drawings										
265219	Qualification Data										
265219	Test Reports										
220544	Product Data - For Each Product										
265219	Product Data - For Each Product										
265219	Shop Drawings										
265219	Qualification Data										
265219	Test Reports										
220544	Product Data - For Each Product										
283111	Product Data - For Each Product										
283111	Shop Drawings										
283111	Qualification Data										
283111	Test Reports										

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SECTION 1.E.4
OPERATING INSTRUCTIONS AND SERVICE MANUAL LOG

Section	Description	Catalog Data	Wiring Diagrams	Installation Instructions	Service & Maintenance Instructions	Parts List & Availability	Performance Curves	Startup & Operating Instructions

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Project: Medical Science Building 7E Renovation
 Project Number: CP2400920
 Contractor:

SECTION 1.E.5
CLOSEOUT LOG

Section	Description	Contractor	Date Rec'd	#	CPM Initials	Remarks
GC 3.1	Contractor's Warranty					
GC 3.15	Record Drawings					
GC 3.16	Operating Instructions					
GC 3.16	Service Manuals					
GC 13.5.6	Final Affidavit of Supplier Diversity Participation for Each Diverse Firm					
COM1-5	Commissioning Checklist Documentation					

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Commissioning Plan

CP2400920 Medical Science Building 7th Floor

Prepared for

University of Missouri

Prepared by

AccuTec
Services, Inc.
www.atsiusa.com

Report Date: 30Aug24

Project No.: 245744

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<u>Title</u>	<u>Section</u>
Commissioning Plan	1
Prerequisites, Tasks and Durations	A
Sample Pre-Functional Check Lists	B
Sample Functional Check Lists	C
Commissioning Schedule	D

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Construction Phase Commissioning Plan
University of Missouri
CP2400920 – Medical Science Building 7th Floor

1. Introduction

- 1.1. This commissioning plan provides an overview of the commissioning process; outlines commissioning events and responsibilities and defines communication paths for this project. The commissioning process and individual responsibilities are detailed within the Appendices.
- 1.2. This Commissioning Plan is a “living document,” meaning that it will become more detailed as it is updated and modified throughout the construction process. The plan provides a simplified schedule and key milestones of the commissioning events. Actual dates are added to the schedule as construction progresses.

2. Commissioning Overview

- 2.1. Commissioning is a systematic process of verifying that all building systems perform interactively according to the design intent and the Owner's operational needs. This is achieved by beginning in the design phase and documenting design intent and continuing through construction, acceptance and the warranty period with verification of installation and performance.
- 2.2. Commissioning during the construction phase is intended to achieve the following specific objectives:
 - 2.2.1. Verify that applicable equipment and systems are installed according to the manufacturer's recommendations and to industry accepted minimum standards and ensure they receive adequate operational checkout by installing contractors.
 - 2.2.2. Verify and document that the installed equipment and systems perform as intended by the Design Team in both summer and winter peak conditions.
 - 2.2.3. Verify that TAB is completed and meets the design specifications.
 - 2.2.4. Verify that the MEP O&M documentation left on site is complete.
 - 2.2.5. Verify that the Owner's operating personnel are adequately trained.
 - 2.2.6. Verify that any observed concerns for MEP functionality are addressed by the Design and Construction Teams.
- 2.3. Commissioning does not take away from or reduce the responsibility of the installing contractors to provide a finished and fully functioning product, nor does it replace the contractor's quality assurance and quality control responsibilities. Commissioning is the Owner's QA/QC and is not intended to be the Contractor's QA/QC or project completion list.

3. Commissioning Team

3.1. Commissioning activities shall in general follow the requirements of the ASHRAE and NEBB Guidelines that focus on the mechanical, electrical, and life safety systems. This Commissioning effort includes the following participants:

3.1.1. Commissioning Team: The Mechanical, Electrical, and Control System subcontractors, as well as the construction manager, design team and Owner's team, have responsibilities associated with commissioning. These responsibilities are outlined in this plan and are detailed in the contract documents.

Owner: University of Missouri			
Project Manager		Phone Cell E-Mail	
Construction Manager		Phone Cell E-Mail	
Design Phase Commissioning Authority (CxA): AccuTec Services, Inc			
Project Manager:	Don Hill 320 NW Capital Dr Lee's Summit, MO 64086	Phone Cell E-Mail	8165258080 8162153966 dhill@atsiusa.com
Construction Phase Commissioning Authority (CxA):			
Project Manager:		Phone Cell E-Mail	
Lead Architect: PGAV			
Mechanical/Plumbing Engineer: Introba			
Mechanical Engineer:		Phone Cell E-Mail	
Electrical Engineer: Antella			
Electrical Engineer:		Phone Cell E-Mail	

Construction Manager (CM):			
		Phone Cell E-Mail	
Mechanical Subcontractor (MC):			
		Phone Cell E-Mail	
Testing, Adjusting & Balancing Agency (TAB):			
		Phone Cell E-Mail	
Electrical Subcontractor (EC):			
		Phone Cell E-Mail	
Life Safety Subcontractor (LS):			
		Phone Cell E-Mail	
Building Automation System Subcontractor (BAS):			
		Phone Cell E-Mail	

4. Management, Reporting and Communication

- 4.1. The design phase Commissioning Authority has been hired by the University of Missouri. The design phase Commissioning Authority performs a design review at the Design Development and 100% Construction Documents set, develop the commissioning specifications, and develop the commissioning plan.
- 4.2. The construction phase Commissioning Authority will be hired by the University of Missouri. The Commissioning Authority directs and coordinates the commissioning activities and reports to the Owner. All members work together to fulfill their contracted responsibilities and meet the objectives of the Contract Documents.
- 4.3. Commissioning related communication and reporting shall be channeled directly between the Commissioning Authority and the Contractor/Construction Manager. The Commissioning Authority will copy the Owner and AE on all commissioning related reports and communications.

- 4.4. Subcontractors will communicate, report, and issue commissioning related submittals directly to the Construction Manager.
- 4.5. The Commissioning Authority has no management authority over any contractors or their subcontractors. To enhance team communication, the Commissioning Authority will communicate directly with subcontractors when authorized by the Owner and Construction Manager.

5. Construction Phase Commissioning Activities

The Commissioning Authority is responsible for coordination of the entire commissioning effort. The specific equipment and systems to be commissioned are identified in the equipment list at the end of this document. This equipment list represents major equipment within the systems to be commissioned; other associated components will be commissioned to provide a complete commissioning effort and report for the equipment/systems.

The following list describes the commissioning coordination activities for this project. Unless noted otherwise, these activities apply to all systems listed in section 6 of this commissioning plan. Further detail on prerequisites and durations of the commissioning activities for each discipline is included in the Appendices to this plan.

- 5.1. Commissioning Specifications: The design phase Commissioning Authority will generate and issue specifications related to the commissioning process.
- 5.2. Design Review: The construction phase Commissioning Authority and the Owner will conduct a design review of the MEP drawings at the Issue For Construction design submittals. Comments will be provided to the AE through the University of Missouri. If necessary to resolve the design review comments, the Commissioning Authority will lead a design review meeting with the AE and Owner to address comments and concerns.
- 5.3. Scoping/Kick-Off Meeting: The construction phase Commissioning Authority will conduct a meeting to review the scope of commissioning with the commissioning team. The purpose is to further explain the role of each of the participants and assist in the overall coordination of the team as it relates to commissioning activities required by this plan and the project specifications.
- 5.4. Commissioning Duration Schedule: Based on the final commissioning plan prepare a duration schedule for the contractors for the commissioning activities required by the commissioning plan. This duration schedule should be incorporated into the contractor's project schedule to track all commissioning activities of the commissioning team.
- 5.5. Coordinate the Commissioning Effort: The construction phase Commissioning Authority will coordinate the commissioning activities, including: scheduling, testing, deficiency resolution, compliance with the contract documents, and information/document exchange with contractor, subcontractors, AE and Owner.
- 5.6. Finalize Commissioning Plan: The construction phase Commissioning Authority will finalize the commissioning plan based on the information exchanged at the scoping meeting.

- 5.7. Submittal Review: The construction phase Commissioning Authority will review the equipment submittals as they relate to commissioning and development of commissioning tests. The Commissioning Authority will not review the submittals for compliance with the contract documents. With the exception of critical path items, the Commissioning Authority shall only review equipment submittals following acceptance by the AE.
- 5.8. Submittal Tracking and Specification Testing Checklist: The construction phase Commissioning Authority will generate a list of the equipment submittals to be reviewed. This list will include field quality control tests required by the specifications.
- 5.9. Develop Construction Checklists (CC) / Pre-Functional Checks (PFC): The construction phase Commissioning Authority will review submittals, including detailed start-up procedures and develop the detailed field installation checklists. The term Construction Checklist (CC) and Pre-Functional Checks (PFC) are interchangeable. These checklists will be used to verify and document proper and complete installation of the systems and their components.
- 5.10. Complete Construction Checklists: The construction phase Commissioning Authority will provide the contractors with the detailed Construction Checklists. The checklists are to be completed by the contractors and returned to Commissioning Authority for verification.
- 5.11. Review and Approve Start-up Plans: The construction phase Commissioning Authority will review and approve contractor submitted start-up plans in conjunction with the Owner. This includes review of temporary systems operational plans.
- 5.12. Site Visits: The commissioning team will visit the construction site during construction to field verify that the installation meets the requirements of the contract documents relating to commissioning items. Further, the Commissioning Authority will verify the information provided by the contractors in the Construction Checklists.
- 5.13. Develop the Functional Testing Procedures (FT): The construction phase Commissioning Authority will review the submittal documents and the early operations and maintenance (O&M) material and develop functional testing procedures. The terms Functional Testing (FT) and Functional Performance Testing (FPT) are interchangeable. The functional testing procedures will be reviewed with the design team and subcontractors as necessary to clarify operation.
- 5.14. Develop the Integrated Systems Testing Procedures (IST): The construction phase Commissioning Authority will review the submittal documents and the early operations and maintenance (O&M) material and develop Integrated Systems Testing procedures. The IST procedures will be reviewed with the design team and subcontractors as necessary to clarify operation.
- 5.15. Facilitate and Document Functional Performance Testing: The construction phase Commissioning Authority will observe and document the mechanical and electrical functional performance testing for the equipment listed in this plan.

5.16. Track Deficiency Resolution: The construction phase Commissioning Authority will document deficiencies and track the resolution of those deficiencies in a Commissioning Issue Log and will periodically issue the list to all parties. Where issues are generated in the performance of Functional Performance Testing, each issue number will be referenced on the Functional Test document.

5.16.1. Retesting of deficient systems is not included in the construction phase Commissioning Authority's scope of work. The additional cost associated with troubleshooting and retesting of the commissioned systems will be charged to the Owner on a time and expense basis. For deficiencies due to lack of quality control/quality assurance, it is the Owner's intent to recover these costs from the contractor.

5.17. Review O&M Manuals for Commissioned Equipment: The construction phase Commissioning Authority will review the official submittal of the As-Built documentation and O&M manuals for accuracy, completeness, overall organization and ease of use with direction and input from the Owner.

5.18. Review Warranty: The construction phase Commissioning Authority will review the warranty documentation with direction and input from the Owner.

5.19. Deferred and/or Seasonal Testing: Testing during the construction phase that cannot be completed due to weather, occupancies, or deficiencies may be deferred to the acceptance phase. The Commissioning Authority will coordinate required deferred testing and update the commissioning report with results.

6. Systems/Equipment to be Commissioned

6.1. The following tables list the systems/items to be commissioned during the commissioning process.

Mechanical Systems

M.1	Blower Coil Units
M.2	Air Terminal Units (Supply and Exhaust)
M.3	Lab Air Control Valves (Supply, General Exhaust, and Fume Hood Exhaust)
M.4	Duct Mounted Reheat Coils

Direct Digital Controls/Building Automation Systems

BAS.1	Sensors
BAS.2	Actuators
BAS.3	Software
	Graphics Interface
	Occupied / Unoccupied Operations
	Alarms

Electrical Systems

E.1	Lighting Controls
E.2	Power Distribution

7. Commissioning Report

- 7.1. The construction phase Commissioning Authority will develop and assemble a final report that documents all commissioning activities for the project. The final report will incorporate the final record documents for each system, as appropriate. The report will also include a summary of commissioning that will highlight the final condition of each system commissioned.

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Construction Phase Commissioning Plan
University of Missouri
CP2400920 – Medical Science Building 7th Floor

APPENDIX A

1. Commissioning Prerequisites, Tasks and Durations

This document reflects the prerequisites, and tasks associated with the commissioning process. The prerequisites must be met prior to the corresponding commissioning activity taking place. The commissioning tasks are broken down per discipline and system. This appendix is a supplement to the commissioning plan.

2. General activities related to commissioning to be incorporated into the construction schedule:

2.1. Start-up plan and schedule: Contractor to submit plan (6 weeks prior to start-up), including, but not limited to:

2.1.1. Airflow requirements

2.1.2. Minimum cooling coil air and water temperature difference

2.1.3. Heating and cooling coil requirements

2.1.4. Supply, return, and exhaust air paths

2.1.5. Minimum system and equipment safety requirements

2.1.6. Minimum maintenance requirements

2.1.7. Temporary TAB values and requirements for the air and hydronic systems

2.2. Review of Start-up Plan and Schedule

2.2.1. Construction phase commissioning authority and Owner review and comment on start-up plan (2 week duration)

2.2.2. Contractor to modify and resubmit start-up plan (1 week)

2.2.3. Construction phase commissioning authority and Owner review and comment on start-up plan (1 week)

2.2.4. Acceptance of final plan and schedule (2 weeks prior to start-up)

2.3. Electrical acceptance testing and submission of testing reports

2.4. Schedule Milestones

2.4.1. BAS installation completion, including programming and QA/QC

2.4.2. Contractor QA/QC completion for commissioned systems

2.4.3. TAB completion

3. Mechanical Commissioning Activities and Requirements

3.1. Documentation requirements precede commissioning activities. Properly executed and signed pre-functional checklists are required prior to Construction phase commissioning authority installation verification activities. Complete shop drawings, manufacturer's start-up reports and product data are required prior to

functional performance testing (FPT/FT). Sub-items for the mechanical equipment noted are listed in chronological order.

- 3.2. Installation verification activities to be incorporated into the construction schedule for each piece of equipment and/or system include:
 - 3.2.1. Construction phase commissioning authority issues PFC (CC) Checklists to CM/GC
 - 3.2.2. Contractor directs and subs perform and document items on checklists.
 - 3.2.3. Construction phase commissioning authority monitors and reviews commissioning installation verification.
- 3.3. TAB verification activities to be incorporated into the construction schedule for each piece of equipment and/or system include:
 - 3.3.1. Receipt and approval of the TAB Preliminary Reports
- 3.4. The prerequisite for the functional performance testing is that all TAB verification for associated systems is complete; all aspects of the BAS system are complete including programming, loop tuning, graphics, and calibration. The intent is for the Contractors to have all associated equipment and systems configured in their final "turn over" state prior to testing of each system.

Functional performance testing activities to be incorporated into the construction schedule for each piece of equipment and/or system include:

 - 3.4.1. All TAB verification complete
 - 3.4.2. All BAS work complete
 - 3.4.3. All Non-Compliance items corrected
 - 3.4.4. Construction phase commissioning authority Commissioning Testing

4. Electrical Commissioning Activities and Requirements

- 4.1. Documentation requirements precede commissioning activities. Properly executed and signed PFC (CC) check sheets are required prior to Construction phase commissioning authority installation verification activities. Complete shop drawings (including short circuit and overcurrent protective device coordination study by Electrical Contractor), manufacturer's start-up reports, factory testing reports and product data are required prior to functional performance testing (FPT/FT).
- 4.2. Installation verification activities to be incorporated into the construction schedule for each piece of equipment and/or system include:
 - 4.2.1. Construction phase commissioning authority issues PFC (CC) Checklists to CM/GC
 - 4.2.2. Contractor directs and subs perform and document items on checklists.
 - 4.2.3. Construction phase commissioning authority monitors and reviews commissioning installation verification.
- 4.3. Acceptance Testing
 - 4.3.1. Acceptance testing of the electrical systems can commence as soon as the systems are installed and at the Electrical Contractor's discretion.
- 4.4. The prerequisite for the functional performance testing is that all acceptance

testing is complete, reports approved, all manufacturers start-up is completed, and any major issues noted during PFC (CC) checklist verification have been resolved.

Functional performance testing activities to be incorporated into the construction schedule for each piece of equipment and/or system include:

- 4.4.1. Installation verified and major issues resolved
- 4.4.2. Start-up and QA/QC complete
- 4.4.3. Construction phase commissioning authority Commissioning Testing
- 4.4.4. On-site testing of the power distribution systems performed by installing contractor and manufacturer's representative per associated specification sections. Testing will be witnessed by Construction phase commissioning authority. The installing contractor shall prepare and submit associated test and inspection reports.

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Construction Phase Commissioning Plan
University of Missouri
CP2400920 – Medical Science Building 7th Floor

APPENDIX B

Pre-Functional Check / Construction Checklist (PFC/CC) Sheets

The following documents reflect the depth of the Pre-Functional Check/Construction Checklist sheets which will be developed by the construction phase Commissioning Authority, executed by the contractor and subcontractors, and verified by the construction phase Commissioning Authority.

The construction phase Commissioning Authority will review the normal submittals, including detailed start-up procedures, and develop the detailed Pre Checklists. The final checklists will be provided to the contractors by the construction phase Commissioning Authority for completion by the contractors. The checklists are to be used to verify proper and complete installation of the required system and their components.

Pre-Functional Checks

Will be generated and incorporated with subsequent Commissioning Plan revisions

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Construction Phase Commissioning Plan
University of Missouri
CP2400920 – Medical Science Building 7th Floor

APPENDIX C

Functional Performance Tests / Functional Test Procedures (FPT/FT)

The following documents reflect the depth of the Functional Performance Testing/Functional Test Procedures to be performed during acceptance testing.

Test procedures will be developed by the construction phase Commissioning Authority and observed/executed by the construction phase Commissioning Authority with assistance from the contractors and subcontractors as noted in the Commissioning Plan, the Commissioning Specifications and Appendix A.

These tests will be developed for each piece of equipment, or system where appropriate, based on the final sequence of operation in the construction documents and using the approved Temperature Control submittals as an additional guideline. The construction phase Commissioning Authority will distribute the final tests to the contractors and design team prior to commissioning for review and comment.

Functional Performance Tests

Will be generated and incorporated with subsequent Commissioning Plan revisions

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Construction Phase Commissioning Plan
University of Missouri
CP2400920 – Medical Science Building 7th Floor

APPENDIX E

Commissioning Schedule

The following commissioning schedule is a “living document,” meaning it will become more detailed as it is updated and modified throughout the construction process. This schedule will be updated by the commissioning team regularly during construction to assist the scheduling of commissioning activities and required team attendance. The commissioning schedule will be updated based on the final construction documents.

The Commissioning Schedule

Will be generated and incorporated with
subsequent Commissioning Plan revisions

CP2400920 Med Science Bldg 7th Flr East Renovation Quality Assurance Log

Verified by:		Date compl	Coord Initial	Documentation Required	Owner Witness Required
Commissioning Items by CSI Division	Name	Firm			
1					
Building System Commissioning					
Commissioning Agent - Conduct pre-installation meetings per specifications.					Meeting Minutes ☒
24119					
Selective Demolition					
Do not start demolition until utility disconnect and sealing has been verified in writing					☒
Hold Preinstallation meeting as specified					Meeting Minutes ☒
28233					
Asbestos Removal					
Develop & Post Emergency Protection Plan					Emergency Protection Plan ☐
55000					
Metal Fabrications					
Provide welder qualification report for each welder on site					Welder Qualifications ☒
64116					
Plastic-Laminate-Clad Architectural Cabinets					
Perform Field Quality Control section of specifications					Test Report ☒
70150					
Roofing Patch and Repair					
Hold pre-installation meeting as specified					Meeting Minutes ☒

Commissioning Items by CSI Division		Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
78413							
Penetration Firestopping							
Inspect firestopped penetrations once filled						Inspection Report	☒
Perform Field Quality Control section of specifications						Test Report	☒
79200							
Joint Sealants							
Perform Field Quality Control section of specifications						field report	☒
81113							
Hollow Metal Doors and Frames							
Inspect label for fire rated doors and frames						itemized list of doors	☒
81213							
Hollow Metal Frames							
Inspect label for fire rated doors and frames						Meeting Minutes	☒
Perform Field Quality Control section of specifications						field report	☒
81416							
Flush Wood Doors							
Conduct a preinstallation conference at project site per specifications						Meeting Minutes	☒
Inspect label for fire rated doors and frames						Door List	☒

Verified by:						
Commissioning Items by CSI Division	Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
Perform Field Quality Control section of specifications					field report	☒
85113						
Aluminum Windows						
Conduct a preinstallation conference at project site per specifications					Document proceedings; provide copy to participants	☒
Perform Field Quality Control section of specifications					Test Reports	☒
87000						
Door Hardware						
Perform Demonstration and Training section of specifications					Sign-in Sheet	☒
Perform Field Quality Control section of specifications					Test Report	☒
Verify that all fire doors close and latch positively					test report	☐
88000						
Glazing						
Clean as required by specifications						☒
92116						
Gypsum Board Shaft Wall Assemblies						
Verify fire rating compliance is maintained, including all wall penetrations. And that fire barriers are stenciled					Inspection Report	☒

Verified by:		Date compl	Coord Initial	Documentation Required	Owner Witness Required
Commissioning Items by CSI Division	Name	Firm			
92900					
Gypsum Board					
Verify fire rating compliance is maintained, including all wall penetrations. And that fire barriers are stenciled					Inspection Report ☒
93013					
Ceramic Tiling					
Provide Extra Material as specified					Transmittal ☒
95113					
Acoustical Tile Ceilings					
Complete all above ceiling inspections prior to installation of tiles					☒
96513					
Resilient Base and Accessories					
Provide Extra Material as specified					Transmittal ☒
96519					
Resilient Tile Flooring					
Perform pH, Chloride (moisture) and bond tests per manufacturer. Do not proceed until all manufacturing requirements are met.					test reports ☒
99123					
Interior Painting					
Periodically Check Wet Film Thickness To Assure Conformance With Manufacturer's Requirements To Achieve Dry Film Thickness Per Field Quality Control section of specs.					field report ☒
Provide Extra Material as specified					Transmittal ☒

Commissioning Items by CSI Division		Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
99600							
High-Performance Coatings							
Perform Field Quality Control section of specifications						Test Report	☒
Provide Extra Material as specified						Transmittal	☒
122413							
Roller Window Shades							
Provide Extra Material as specified						Transmittal	☒
123553							
Laboratory Casework, Furniture and Worksurfaces							
Build Mockup as specified						Inspection Report	☒
Provide Extra Material as specified						Transmittal	☒
211000							
Water Based Fire Suppression Systems							
Perform Field Quality Control section of specifications						NFPA 13 Certification	☒
Provide Extra Material as specified						Transmittal	☒
Provide system operation & maintenance training Per Demonstration section of specifications						Sign In Sheet	☒

Commissioning Items by CSI Division		Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
220100							
Basic Plumbing Requirements							
Hold MEP pre-installation meeting(s).						Meeting Minutes	☒
220523							
Valves							
Adjust or replace packing after piping system testing and put into service prior to testing and balancing							☐
220700							
Plumbing Piping Insulation							
Verify all valve stems are extended and accessible							☐
221116							
Domestic Water Piping							
Perform Disinfection of Domestic Water Piping System section of specifications						Bacteria test results	☒
Provide pressure testing per Field Quality Control section of specifications						test report	☒
221119							
Domestic Water Piping Specialties							
Perform Field Quality Control section of specifications						Test Report	☒
221316							
Sanitary Waste and Vent Piping							
Perform leak test per Field Quality Control section of specifications						test report	☒

Commissioning Items by CSI Division		Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
224300							
Plumbing Fixtures							
Adjust water pressure at drinking fountains, electric water coolers, faucets, shower valves, and flushometer valves. Verify proper flow and stream.							☐
226113							
Compressed-Air Piping for Laboratory Facilities							
Inspect, test and certify per Field Quality Control section of specifications						Test Report	☒
226213							
Vacuum Piping for Laboratory and Healthcare Facilities							
Perform Field Quality Control for Laboratory Facility Nonmedical Vacuum Piping section of specifications						Test Report	☒
226700							
Processed Water Piping for Laboratory and Healthcare Facilities							
Perform Field Quality Control section of specifications						Test Report	☒
226800							
Facility Natural-Gas Piping							
Perform Field Quality Control section of specifications						Test Report	☒
Provide factory training per Demonstration section of spec						Sign-In Sheet	☒
230100							
Basic Mechanical Requirements							
Hold MEP pre-installation meeting(s).						Meeting Minutes	☒

Verified by:		Date compl	Coord Initial	Documentation Required	Owner Witness Required
Commissioning Items by CSI Division	Name	Firm			
230513					
Motors					
Check each motor for alignment, lubrication, rotation, voltage and current and Efficiency				List of motors	☒
230519					
Meters and Gages					
Install test plugs where specified and at owner representative directive					☐
230523					
Valves					
Verify proper valve operators and stems are installed					☐
230700					
Mechanical Insulation					
Verify all valves & damper controls are extended and accessible					☐
230900					
Control Systems					
Check and record amp draw on supply transformers of I/O panels				Test Report	☒
Ensure shipping material has been removed from thermostats and other control devices					☐
Post laminated control diagram in mechanical room					☐
Test and adjust temperature controls in coordination with TAB engineer					☐

Verified by:						
Commissioning Items by CSI Division	Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
230990						
Testing, Adjusting, and Balancing						
Confirm approved shop drawings, as-builts, O&Ms and change orders have been submitted to the TAB engineer prior to testing and balancing						☐
Coordinate and cooperate with owner's commissioning efforts						☐
Coordinate temperature control testing and adjusting with temperature controls contractor						☐
Ensure pre-test requirements as specified in paragraph 1.2C have been completed						☐
Hold Pre Balancing Conference as specified					Meeting Minutes	☒
232113						
Hydronic Piping						
Pressure test piping per Field Quality Control section of specifications					test report	☒
Provide Extra Materials as specified					Transmittal	☒
Remove and clean all strainers after flushing system					Flush Report	☒
233113						
Metal Ducts						
Test per Field Quality Control section of spec. per leakage class specified. (leakage class 6).					Test Report	☒

Verified by:		Date compl	Coord Initial	Documentation Required	Owner Witness Required
Commissioning Items by CSI Division	Name	Firm			
233300					
Duct Accessories					
Demonstrate Proper Operation of All Fire Dampers per NFPA-90A.				Inspection Report	☒
Perform Field Quality Control section of specifications- include inspection of all fire dampers.				Test Report	☒
Provide Extra Materials as specified				Transmittal	☒
233419					
Laboratory Mechanical Systems					
Perform Commissioning section of specifications				Commissioning Report	☐
Perform Demonstration section of specifications				Sign In sheet	☒
Perform Field Quality Control section of specifications				Test Report	☒
Provide Extra Materials as specified				Transmittal	☒
233600					
Air Terminal Units					
Perform Field Quality Control section of specifications				Test Report	☒
237313					
Modular Packaged Air-Handling Unit					
Commission per specifications				Cx Report	☒

Verified by:						
Commissioning Items by CSI Division	Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
Provide Extra Materials as specified					Transmittal	☒
Train Owners Personnel					Sign In Sheet	☒
238216						
Duct Mounted Coils						
Perform Field Quality Control section of specifications					Test Report	☒
260500						
Common Work Results for Electrical						
Install Firestopping as specified					Inspectin Report	☒
260519						
Low-Voltage Electrical Power Conductors and Cables						
Ensure wires are color coded per specifications						☐
Perform independent tests per "Field Quality Control" section of spec, including megohm/high pot tests					test report	☐
260526						
Grounding and Bonding for Electrical Systems						
Perform resistance test per field Quality Control section of specifications					test report	☒
260536						
Cable Trays for Electrical/ Communications Systems						
Perform resistance test as described in "Field Quality Control" section of spec					continuity test	☒

Verified by:		Date compl	Coord Initial	Documentation Required	Owner Witness Required
Commissioning Items by CSI Division	Name	Firm			
260548					
Seismic Controls for Electrical Systems					
Perform resistance test as described in "Field Quality Control" section of spec				Test Report	☒
260553					
Identification for Electrical Systems					
Verify all equipment, panels, conduits and conductors are correctly labeled.					☐
260572					
Overcurrent Protective Device Short-Circuit Study					
Place arcflash labels on equipment as specified					☒
SKM data to be e-mailed to MU Commissioning Engineer				SKM Data	☒
Train owners representatives in setting of overcurrent devices				Sign-up Sheet	☒
260573					
Overcurrent Protective Device Coordination Study					
Factory certified technician to set electronic overcurrent devices to approved coordination study setpoints				Inspection Report	☒
260574					
Overcurrent Protective Device Arc-Flash Study					
perform Labeling Section of spec				Inspection Report	☒
Perform 'Testing' section of specifications				Test Report	☒

Commissioning Items by CSI Division		Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
260923							
Lighting Control Devices							
Perform tests as described in "Field Quality Control" section of spec						field report	☒
Provide factory training per Demonstration section of spec.						Sign in sheet	☒
262200							
Low-Voltage Transformers							
Perform checks and tests as noted in "Field Quality Control" section of spec						test report	☒
262416							
Panelboards							
Perform checks per "Field Quality Control" section of spec						Test Report	☒
provide extra keys as specified						transmittal	☒
262726							
Wiring Devices							
Perform checks per "Field Quality Control" section of spec						Test Report	☒
262813							
Fuses							
Furnish Extra Materials as specified							☒
262816							
Enclosed Switches and Circuit Breakers							
Furnish Extra Materials as specified						Transmittal	☒

Verified by:						
Commissioning Items by CSI Division	Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
Perform tests per "Field Quality Control" section of spec					Test Report	☒
265119						
LED Interior Lighting						
Furnish Extra Materials as specified					Transmittal	☒
Perform all tests as noted in "Field Quality Control" section of spec					Test Report	☒
265219						
Emergency and Exit Lighting						
Illuminate emergency lights for 90 minutes on battery power.					Test Report	☒
Illuminate exit lights for 90 minutes on battery power.					Test Report	☒
Perform all tests as noted in "Field Quality Control" section of spec					Test Report	☒
283111						
Digital, Addressable Fire-Alarm System						
Factory Rep Shall Perform and document all testing as required in specs. A log of all devices and the testing performed shall be maintained. Perform all testing in the presence of the Owner's Rep					field reports, certification, NFPA-72	☒
Perform checks per "Field Quality Control" section of spec					NFPA Certification	☒
Precheck all fire alarm devices					Precheck Checklist	☐
Provide factory training per demonstration section of spec.					Sign in sheet	☒

Verified by:						
Commissioning Items by CSI Division	Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
Verify operation of each notification device						☒
Verify room sensors labeled						☐
Verify smoke dampers installed						☐
Verify tamper/flow switches operational						☒

Please see following website for suggested commissioning forms:

<https://operations.missouri.edu/facilities/commissioning-forms>

Construction Management Checklist for Energizing Utilities

(Contractor to initial each item upon completion and provide completed form to the Owner's Representative prior to energizing utility)

AM #1

Water – turned on to the first valve past Energy Management's last valve.

- ☐ Review all piping and equipment being turned on for proper installation and completed testing.
- ☐ Insulation installed (preferred but not required)
- ☐ Meter properly installed, working, and in readable location.
- ☐ Contractor has swabbed out with chlorine all piping from the backflow preventer to the source while installing.
- ☐ All bacteriological tests have been completed and passed.
- ☐ Backflow preventer installed and tested. (will need water pressure to test)
- ☐ Pressure test completed in piping being turned on.
- ☐ Contractor has method to communicate "Services On" to other contractor personnel and Owner's personnel.
- ☐ Consultant has signed off

Steam – turned on to the first valve past Energy Management's last valve.

- ☐ Review all piping, equipment, valves, reducing stations, relief valves, etc. for proper installation and complete testing.
- ☐ Piping protected from the weather.
- ☐ Insulation must be installed.
- ☐ All hangers and bolts have been installed.
- ☐ Meter installed, working and in readable location. (Don't need metasys to turn on.)
- ☐ All needed traps are installed and able to be tested as they are turned on.
- ☐ Condensate system is installed and operating including the pumping system.
- ☐ Pressure test completed in piping being turned on.
- ☐ Contractor has method to communicate "Services On" to other contractor personnel and Owner's personnel.
- ☐ Consultant has signed off

Condensate – turned on to the first valve past Energy Management's last valve.

- ☐ Review all piping and equipment being turned on for proper installation and completed testing.
- ☐ Piping protected from the weather.
- ☐ Insulation installed (preferred but not required)
- ☐ Pressure test completed in piping being turned on.
- ☐ Contractor has method to communicate "Services On" to other contractor personnel and Owner's personnel.
- ☐ Consultant has signed off

Electric – turned on to the first breaker past 13.8kV transformer.

- ☐ Review all wiring and equipment being turned on for proper installation and completed testing
- ☐ GFCI set and tested.
- ☐ Breakers set and tested.
- ☐ All needed permanent grounds are installed.
- ☐ Meter installed, working and in readable location.
- ☐ Main switchgear protected from the weather.
- ☐ Contractor has method to communicate "Services On" to other contractor personnel and Owner's personnel.
- ☐ Consultant has signed off

Chilled Water – turned on to the first valve inside of building.

- ☐ Review all piping and equipment being turned on for proper installation and completed testing.
- ☐ Pressure test completed in piping being turned on.
- ☐ Insulation must be installed.
- ☐ Meter installed, working and connected to Metasys.
- ☐ Building pump and automatic isolation/control valve must be installed and under control.
- ☐ If chillers are installed, automatic loop pump isolation must be installed.
- ☐ Control valves must be installed and automatically controlled on all loads.
- ☐ Contractor has method to communicate "Services On" to other contractor personnel and Owner's personnel.
- ☐ Consultant has signed off

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SECTION 1.F

INDEX OF DRAWINGS

Drawings referred to in and accompanying this Project Manual consist of the following sheets dated July 8, 2025.

OPTION 'L'

ARCHITECTURAL

A003L	COVER
A105L	GENERAL INFORMATION
A106L	TYPICAL PARTITIONS & INTERIOR DETAILS
A107L	UL-RATED ASSEMBLIES
A108L	UL-RATED ASSEMBLIES
A109L	UL-RATED ASSEMBLIES
A175L	LEVEL 7 & ROOF – CODE PLAN - OVERALL
A176L	LEVEL 7 – ENLARGED CODE PLAN BASE
A275L	ORIGINAL DESIGN – FOR REFERENCE ONLY
A276L	DEMOLITION PLAN - LEVEL 7 - EAST
A277L	DEMOLITION RCP - LEVEL 7 - EAST
A285L	DEMOLITION PLAN - ROOF
A376L	LEVEL 7 PLAN - EAST
A377L	LEVEL 7 ENLARGED PLAN – AREA 'G'
A385L	ROOF PLAN - OVERALL
A675L	LEVEL 7 REFLECTED CEILING PLAN - EAST
A702L	LEVEL 7 DOOR & OPENING SCHEDULES
A805L	CASEWORK & LAB DETAILS
A870L	LEVEL 7 INTERIOR ELEVATIONS
A905L	FINISH LEGEND & DETAILS
A906L	SIGNAGE PLAN
A970L	FINISH PLAN – LEVEL 7 EAST

STRUCTURAL

S101L	GENERAL NOTES, PLANS, & DETAILS

FIRE PROTECTION

FP000L	FIRE PROTECTION SYMBOLS AND ABBREVIATIONS
FP373L	LEVEL 7 – FIRE PROTECTION NEW WORK PLAN - EAST
FP374L	LEVEL 7 – FIRE PROTECTION NEW WORK PLAN - WEST
FP502L	FIRE PROTECTION DETAILS

PLUMBING

P000L	PLUMBING SYMBOLS AND ABBREVIATIONS
P272L	LEVEL 7 - PLUMBING DEMOLITION PLAN - EAST
P375L	LEVEL 7 - PLUMBING NEW WORK PLAN - EAST
P376L	LEVEL 7 - PLUMBING LAB GAS NEW WORK PLAN - EAST
P501L	PLUMBING DETAILS
P601L	PLUMBING SCHEDULES

MECHANICAL

M001L	MECHANICAL SYMBOLS & ABBREVIATIONS
M275L	LEVEL 7 – MECHANICAL DUCTWORK DEMO PLAN - EAST
M276L	LEVEL 7 – MECHANICAL PIPING DEMO PLAN - EAST
M375L	LEVEL 7 – DUCTWORK NEW WORK PLAN – EAST
M376L	LEVEL 7 – MECHANICAL PIPING NEW WORK PLAN – EAST
M383L	ROOF DEMOLITION & NEW WORK PLAN EAST
M505L	MECHANICAL DETAILS
M506L	MECHANICAL DETAILS
M606L	MECHANICAL SCHEDULES
M713L	MECHANICAL CONTROLS

M714L MECHANICAL CONTROLS
M715L MECHANICAL CONTROLS

ELECTRICAL

E010L 7E - ELECTRICAL GENERAL NOTES & LEGEND
E175L LEVEL 7 PLAN – ELECTRICAL DEMO - EAST
E275L LEVEL 7 PLAN – LIGHTING - EAST
E375L LEVEL 7 PLAN – POWER - EAST
E475L LEVEL 7 PLAN – HVAC POWER – EAST
E485L LEVEL 7 PLAN – HVAC POWER – EAST
E675L 7E - ELECTRICAL DETAILS
E676L 7E - ELECTRICAL DETAILS
E775L 7E - RISER DIAGRAM - DEMOLITION
E776L 7E - RISER DIAGRAM – NEW WORK
E805L 7E - LUMINAIRE AND CONTROL SCHEDULES
E875L PANELBOARD SCHEDULES LEVEL 7
E876L PANELBOARD SCHEDULES LEVEL 7

FIRE ALARM

FA175L LEVEL 7 PLAN - FIRE ALARM – EAST

OPTION 'M'

ARCHITECTURAL

A003M COVER
A105M GENERAL INFORMATION
A106M TYPICAL PARTITIONS & INTERIOR DETAILS
A107M UL-RATED ASSEMBLIES
A108M UL-RATED ASSEMBLIES
A109M UL-RATED ASSEMBLIES
A175M LEVEL 7 & ROOF – CODE PLAN - OVERALL
A176M LEVEL 7 – ENLARGED CODE PLAN BASE
A177M LEVEL 7 – ENLARGED CODE PLAN ALTERNATE
A276M DEMOLITION PLAN - LEVEL 7 - EAST
A277M DEMOLITION RCP - LEVEL 7 - EAST
A285M DEMOLITION PLAN - ROOF
A375M LEVEL 7 PLAN OVERALL
A376M LEVEL 7 PLAN - EAST
A377M LEVEL 7 ENLARGED PLAN – AREA 'G'
A385M ROOF PLAN - OVERALL
A675M LEVEL 7 REFLECTED CEILING PLAN - EAST
A702M LEVEL 7 DOOR & OPENING SCHEDULES
A805M CASEWORK & LAB DETAILS
A870M LEVEL 7 INTERIOR ELEVATIONS
A905M FINISH LEGEND & DETAILS
A906M SIGNAGE PLAN
A970M FINISH PLAN – LEVEL 7 EAST
A975M FURNITURE PLAN – LEVEL 7 EAST

STRUCTURAL

S101M GENERAL NOTES, PLANS, & DETAILS

FIRE PROTECTION

FP000M FIRE PROTECTION SYMBOLS AND ABBREVIATIONS
FP373M LEVEL 7 – FIRE PROTECTION NEW WORK PLAN - EAST
FP374M LEVEL 7 – FIRE PROTECTION NEW WORK PLAN - WEST
FP502M FIRE PROTECTION DETAILS

PLUMBING

P000M	PLUMBING SYMBOLS AND ABBREVIATIONS
P272M	LEVEL 7 - PLUMBING DEMOLITION PLAN - EAST
P374M	LEVEL 6 – PLUMBING EXISTING PLAN - EAST
P375M	LEVEL 7 - PLUMBING NEW WORK PLAN - EAST
P376M	LEVEL 7 - PLUMBING LAB GAS NEW WORK PLAN - EAST
P501M	PLUMBING DETAILS
P601M	PLUMBING SCHEDULES

MECHANICAL

M001M	MECHANICAL SYMBOLS & ABBREVIATIONS
M275M	LEVEL 7 – MECHANICAL DUCTWORK DEMO PLAN - EAST
M276M	LEVEL 7 – MECHANICAL PIPING DEMO PLAN - EAST
M375M	LEVEL 7 – DUCTWORK NEW WORK PLAN – EAST
M376M	LEVEL 7 – MECHANICAL PIPING NEW WORK PLAN – EAST
M383M	ROOF DEMOLITION & NEW WORK PLAN EAST
M482M	EAST PENTHOUSE PLANS – DEMOLITION & NEW WORK
M505M	MECHANICAL DETAILS
M506M	MECHANICAL DETAILS
M606M	MECHANICAL SCHEDULES
M713M	MECHANICAL CONTROLS
M714M	MECHANICAL CONTROLS
M715M	MECHANICAL CONTROLS
M872M	LEVEL 7 AIR BALANCE PLAN EAST

ELECTRICAL

E010M	7E - ELECTRICAL GENERAL NOTES & LEGEND
E175M	LEVEL 7 PLAN – ELECTRICAL DEMO - EAST
E275M	LEVEL 7 PLAN – LIGHTING - EAST
E375M	LEVEL 7 PLAN – POWER - EAST
E475M	LEVEL 7 PLAN – HVAC POWER - EAST
E675M	7E - ELECTRICAL DETAILS
E676M	7E - ELECTRICAL DETAILS
E775M	7E - RISER DIAGRAM - DEMOLITION
E776M	7E - RISER DIAGRAM – NEW WORK
E805M	7E - LUMINAIRE AND CONTROL SCHEDULES
E875M	PANELBOARD SCHEDULES LEVEL 7
E876M	PANELBOARD SCHEDULES LEVEL 7

FIRE ALARM

FA175M	LEVEL 7 PLAN - FIRE ALARM - EAST

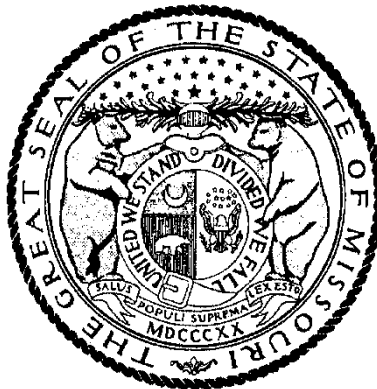
END OF SECTIONS

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Missouri

Division of Labor Standards

WAGE AND HOUR SECTION



MICHAEL L. PARSON, Governor

Annual Wage Order No. 31

Section 010
BOONE COUNTY

In accordance with Section 290.262 RSMo 2000, within thirty (30) days after a certified copy of this Annual Wage Order has been filed with the Secretary of State as indicated below, any person who may be affected by this Annual Wage Order may object by filing an objection in triplicate with the Labor and Industrial Relations Commission, P.O. Box 599, Jefferson City, MO 65102-0599. Such objections must set forth in writing the specific grounds of objection. Each objection shall certify that a copy has been furnished to the Division of Labor Standards, P.O. Box 449, Jefferson City, MO 65102-0449 pursuant to 8 CSR 20-5.010(1). A certified copy of the Annual Wage Order has been filed with the Secretary of State of Missouri.

Original Signed by

Todd Smith, Director
Division of Labor Standards

Filed With Secretary of State: March 8, 2024

Last Date Objections May Be Filed: April 8, 2024

Prepared by Missouri Department of Labor and Industrial Relations

OCCUPATIONAL TITLE	**Prevailing Hourly Rate
Asbestos Worker	\$61.30
Boilermaker	\$32.35*
Bricklayer-Stone Mason	\$55.22
Carpenter	\$51.42
Lather	
Linoleum Layer	
Millwright	
Pile Driver	
Cement Mason	\$45.65
Plasterer	
Communication Technician	\$57.87
Electrician (Inside Wireman)	\$58.36
Electrician Outside Lineman	\$32.35*
Lineman Operator	
Lineman - Tree Trimmer	
Groundman	
Groundman - Tree Trimmer	
Elevator Constructor	\$32.35*
Glazier	\$65.64
Ironworker	\$69.98
Laborer	\$43.79
General Laborer	
First Semi-Skilled	
Second Semi-Skilled	
Mason	\$59.96
Marble Mason	
Marble Finisher	
Terrazzo Worker	
Terrazzo Finisher	
Tile Setter	
Tile Finisher	
Operating Engineer	\$65.05
Group I	
Group II	
Group III	
Group III-A	
Group IV	
Group V	
Painter	\$41.79
Plumber	\$72.46
Pipe Fitter	
Roofer	\$55.00
Sheet Metal Worker	\$58.29
Sprinkler Fitter	\$65.10
Truck Driver	\$32.35*
Truck Control Service Driver	
Group I	
Group II	
Group III	
Group IV	

*The Division of Labor Standards received fewer than 1,000 reportable hours for this occupational title. The public works contracting minimum wage is established for this occupational title using data provided by Missouri Economic Research and Information Center.

**The Prevailing Hourly Rate includes any applicable fringe benefit amounts for each occupational title as defined in RSMo Section 290.210.

Heavy Construction Rates for
BOONE County

Section 010

OCCUPATIONAL TITLE	**Prevailing Hourly Rate
Carpenter	\$63.45
Millwright	
Pile Driver	
Electrician (Outside Lineman)	\$80.19
Lineman Operator	
Lineman - Tree Trimmer	
Groundman	
Groundman - Tree Trimmer	
Laborer	\$50.35
General Laborer	
Skilled Laborer	
Operating Engineer	\$66.32
Group I	
Group II	
Group III	
Group IV	
Truck Driver	\$32.35*
Truck Control Service Driver	
Group I	
Group II	
Group III	
Group IV	

Use Heavy Construction Rates on Highway and Heavy construction in accordance with the classifications of construction work established in 8 CSR 30-3.040(3).

Use Building Construction Rates on Building construction in accordance with the classifications of construction work established in 8 CSR 30-3.040(2).

If a worker is performing work on a heavy construction project within an occupational title that is not listed on the Heavy Construction Rate Sheet, use the rate for that occupational title as shown on the Building Construction Rate Sheet.

*The Division of Labor Standards received fewer than 1,000 reportable hours for this occupational title. Public works contracting minimum wage is established for this occupational title using data provided by Missouri Economic Research and Information Center.

**The Prevailing Hourly Rate includes any applicable fringe benefit amounts for each occupational title.

OVERTIME and HOLIDAYS

OVERTIME

For all work performed on a Sunday or a holiday, not less than twice (2x) the prevailing hourly rate of wages for work of a similar character in the locality in which the work is performed or the public works contracting minimum wage, whichever is applicable, shall be paid to all workers employed by or on behalf of any public body engaged in the construction of public works, exclusive of maintenance work.

For all overtime work performed, not less than one and one-half (1½) the prevailing hourly rate of wages for work of a similar character in the locality in which the work is performed or the public works contracting minimum wage, whichever is applicable, shall be paid to all workers employed by or on behalf of any public body engaged in the construction of public works, exclusive of maintenance work or contractual obligation. For purposes of this subdivision, **"overtime work"** shall include work that exceeds ten hours in one day and work in excess of forty hours in one calendar week; and

A thirty-minute lunch period on each calendar day shall be allowed for each worker on a public works project, provided that such time shall not be considered as time worked.

HOLIDAYS

January first;
The last Monday in May;
July fourth;
The first Monday in September;
November eleventh;
The fourth Thursday in November; and
December twenty-fifth;

If any holiday falls on a Sunday, the following Monday shall be considered a holiday.

SECTION 1.H

ALTERNATES

Base Bid may be increased in accordance with following Additive Alternate proposal(s) as Owner may elect:

OPTION 'M':

A. Add Alternate No. M1: Additional Fire Protection Area 1A

1. Base Bid: Provide fire protection system as shown on FP drawings for the primary areas of renovation only – Orange & Yellow areas on architectural sheet A375M. Connect existing fire sprinkler piping to system & install heads, Ref. FP Drawings.
2. Alternate: Provide additional fire protection system as shown on FP drawings for existing Area 1A – Green areas on architectural sheet A375M. Connect existing fire sprinkler piping to system & install heads temporarily support ceilings, lighting, and ceiling mounted devices in this area.

B. Add Alternate No. M2: Additional Fire Protection Area 1B

1. Base Bid: Provide fire protection system as shown on FP drawings for the primary areas of renovation only – Orange & Yellow areas on architectural sheet A375M. Connect existing fire sprinkler piping to system & install heads, Ref. FP Drawings.
2. Alternate: Provide additional fire protection system as shown on FP drawings for existing Area 1B – Blue area on architectural sheet A375M. Install all new sprinkler system (no existing piping). temporarily support ceilings, lighting, and ceiling mounted devices in this area.

C. Add Alternate No. M3: Restroom Renovation M719 & M720

1. Base Bid: Existing Men's and Women's restrooms to remain in their current configuration.
2. Alternate: Provide demolition and renovation of existing restrooms as indicated on drawings.

D. Add Alternate No. M4: Plumbing Piping Demolition & Rework in Lab M702 & Corridor M723

1. Base Bid: Existing plumbing piping in Lab M702 & Corridor M723 to remain. Ref. Plumbing Drawings.
2. Alternate: Provide demolition and rework of existing plumbing piping in Lab M702 & Corridor M723. Ref. Plumbing Drawings for extent.

E. Add Alternate No. M5: Plumbing Piping Demolition & Rework in Northeast Corridor M727

1. Base Bid: Existing plumbing piping in Northeast Corridor M727 to remain. Ref. Plumbing Drawings.
2. Alternate: Provide demolition and rework of existing plumbing piping in Northeast Corridor M727. Ref. Plumbing Drawings for extent.

OPTION 'L':

A. Add Alternate No. L1: LED Light Fixtures in Lieu of Fluorescent Fixtures

1. Base Bid: Provide equivalent light fixtures in fluorescent - standard recessed, lensed troffers and standard pendant wraparounds. If the existing lights are no longer offered in fluorescent, provide new light fixtures that are the "equivalent" LED versions with same fixture grade. See electrical drawings.
2. Alternate: Provide new LED light fixtures in lieu of the compact fluorescent light fixtures. Keeping the same lighting controls as currently shown. See electrical drawings.

B. Add Alternate No. L2: Replace All Existing Bubble Wrap Ductwork Outside Primary Renovation Area

1. Base Bid: Existing bubble wrap ductwork to remain outside of high impact area – West of Stair MW700. Existing ceilings and light fixtures also remain outside of high impact area.
2. Alternate: Remove and replace existing bubble wrap ductwork in areas beyond high impact area – West of Stair MW700 – as shown on mechanical drawings. Also, provide new LED light fixtures and ceilings as shown on architectural and electrical drawings.

C. Add Alternate No. L3: Plumbing Piping Demolition & Rework in Lab M702 & Corridor M723

1. Base Bid: Existing plumbing piping in Lab M702 & Corridor M723 to remain. Ref. Plumbing Drawings.
2. Alternate: Provide demolition and rework of existing plumbing piping in Lab M702 & Corridor M723. Ref. Plumbing Drawings for extent.

D. Add Alternate No. L4: Plumbing Piping Demolition & Rework in Northeast Corridor M727

1. Base Bid: Existing plumbing piping in Northeast Corridor M727 to remain. Ref. Plumbing Drawings.
2. Alternate: Provide demolition and rework of existing plumbing piping in Northeast Corridor M723. Ref. Plumbing Drawings for extent.

END OF SECTION

SECTION 019113 - GENERAL COMMISSIONING REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes general requirements that apply to implementation of commissioning without regard to systems, subsystems, and equipment being commissioned.
- B. A Commissioning Authority (CxA), appointed by the Owner, will manage the commissioning process.
- C. Related Sections include the following:
 - 1. Section 230800, Mechanical Commissioning Requirements, for specific requirements for commissioning HVAC systems.
 - 2. Section 260800, Electrical Commissioning Requirements, for specific requirements for commissioning electrical systems.
 - 3. Division 22, 23, and 26 Sections - Individual Sections stipulate installation, startup, warranty and training requirements for the system or device specified in that Section.

1.2 REFERENCES

- A. ASHRAE Guideline 0-2013: The HVAC Commissioning Process.
- B. ANSI/NEBB S110-2019 - Whole Building Technical Commissioning of New Construction

1.3 DEFINITIONS

- A. Acceptance Phase - The phase of the project when the facility and its systems and equipment are reviewed, tested, and verified. Most of the functional performance testing occurs during this phase of the project. It will generally occur after the Construction Phase is complete including execution of checklists and startup. The Acceptance Phase typically begins with Substantial Completion and ends with Functional Completion.
- B. ASHRAE - American Society of Heating, Refrigeration, and Air-Conditioning Engineers
- C. Commissioning (Cx) - The process of verifying all building systems are installed and perform interactively according to the design intent; the systems are efficient, cost effective and meet the Owner's operational needs; and the installation is adequately documented.
- D. Commissioning Authority (CxA) - An individual or company who will oversee the commissioning process; stipulate many of the commissioning requirements; and verify that systems and equipment are designed, installed and tested to meet the Owner's requirements.
- E. Commissioning Team - A group of individuals who will collaborate to ensure the facility is fully and completely commissioned. This team will include the Commissioning Authority, the

Owner's representative, the TAB contractor and a commissioning coordinator provided by the Contractor. Generally the installing contractor, subcontractor and manufacturer will also be an integral member of the team for any given system or equipment.

- F. Construction Phase – The phase of the project during which the facility is constructed and/or systems and equipment are installed and started. During this phase Contractors complete installation startup forms, submit operation and maintenance (O&M) information, establish trends, etc. The Construction Phase will generally end upon the completed startup and TAB of systems and equipment.
- G. Contractor - As used herein is a general reference to the applicable installing party and can therefore refer to the construction manager, general contractor, subcontractors, or vendors.
- H. Deficiency - An installation or condition that is not in conformance with the construction documents and/or the design intent.
- I. Functional Completion - A milestone that marks the successful completion of the Acceptance Phase. It generally includes the functional performance testing of the systems in the initial season.
- J. Functional Performance Testing - The dynamic testing of systems and equipment under various modes of operation and different conditions. Both component performance and environmental objectives will be monitored during this testing.
- K. Party - Individual, company or entity involved in the construction and commissioning activities of the project. Refer to the Commissioning Plan for names, roles and responsibilities.
- L. Prefunctional Check – The static testing of equipment to establish that the equipment has been installed correctly.
- M. Scheduled Outage – A period of time scheduled by the Owner in which the system is out of service or not in use by the occupants.
- N. Startup - A process whereby the Contractor verifies the proper installation of a device or piece of equipment, executes the manufacturer's starting procedures, completes the startup checklist, and energizes the device or system, and verifies it is in proper working order.
- O. Systems, Subsystems, and Equipment - Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, and equipment.
- P. TAB - Testing, Adjusting and Balancing as specified in Section 230593.
- Q. Warranty Phase - Includes the early occupancy of the building and continues through the warranty period into the opposite season from when the system was initially tested.

1.4 GENERAL DESCRIPTION

- A. Commissioning is a process to assure all building systems are installed and perform interactively according to the design intent; the systems are efficient, cost effective and meet the Owner's operational needs; the installation is adequately documented; and

operating personnel are adequately trained. Commissioning serves as a tool to minimize post-occupancy operational problems. It establishes testing and communication protocols in an effort to advance building systems from installation to fully optimized operation.

- B. The Commissioning Authority will work with the Contractor to coordinate, oversee, and document the commissioning process during the Construction and Occupancy/Acceptance Phases of this project.
- C. Commissioning during the construction phase is intended to achieve the following specific objectives according to the Contract Documents:
 - 1. Verify that applicable equipment and systems are installed according to the manufacturer's recommendations and to industry accepted minimum standards and that they receive adequate operational checkout by installing contractors.
 - 2. Verify and document proper performance of equipment and systems.
 - 3. Verify that O&M documentation left on site is complete.
- D. Commissioning does not take away from or reduce the responsibility of the installing contractors to provide a finished and fully functioning product, nor does it replace the contractor's quality assurance and quality control responsibilities. Commissioning is the Owner's QA/QC and is not intended to be the Contractors QA/QC or project completion list.

1.5 COMMISSIONING TEAM

- A. Members Appointed by the Construction Manager, Sub Contractors, Architect and Engineer approved by the Owner's Representative: Individuals, each having authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated actions. The commissioning team shall consist of, but not be limited to, representatives of Contractor, including project superintendent, architect and engineering design professionals, and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.
- B. Members Appointed by Owner:
 - 1. Representatives of the facility user and operation and maintenance personnel.
 - 2. Architect and engineering design professionals who are not the Architect/Engineer designers of record.

1.6 COMMISSIONING PROCESS

- A. The following narrative provides a brief overview of the typical commissioning tasks during construction and the general order in which they occur.
 - 1. Commissioning during construction begins with a scoping meeting conducted by the CxA where the commissioning process is reviewed with the commissioning team members.
 - 2. Additional meetings will be required throughout construction, scheduled by the CxA with necessary parties attending, to plan, scope, coordinate, schedule future activities and resolve problems.

3. Equipment documentation is submitted to the CxA during normal submittals, including detailed startup procedures.
4. The CxA works with the Contractors in developing startup plans and startup documentation formats, including providing the Contractors with prefunctional checklists to be completed, during the startup process. The CxA will review contractor submitted start-up plans in conjunction with the Owner. This includes review of any temporary system operational plans (if allowed by the Owner).
5. In general, the checkout and performance verification proceeds from simple to complex; from component level to equipment to systems and intersystem levels with prefunctional checklists being completed before functional testing.
6. The Contractors, under their own direction, execute and document the forms and checklists included in the startup plans. The CxA documents that the startup was completed according to the approved plans. This may include the CxA witnessing startup of selected equipment.
7. The Commissioning Authority will review the submittal documents and the early operations and maintenance (O&M) material and develop functional testing procedures. The functional testing procedures will be reviewed with the design team and subcontractors as necessary to clarify operation.
8. The functional tests are executed by the Contractors, under the direction of, and documented by the CxA.
9. The CxA reviews equipment performance trend data obtained during the maximum heating and cooling seasons.
10. The CxA reviews the O&M documentation for completeness and accuracy.
11. Deferred testing is conducted, as specified or required.

1.7 CONTRACTOR'S RESPONSIBILITIES

- A. Facilitate the coordination of the commissioning work by the CxA, and ensure that commissioning activities are being included in the project schedule.
- B. Provide schedule for operation and maintenance data submittals, equipment startup, and testing to CxA for incorporation into the commissioning plan. Update schedule on a weekly basis throughout the construction period.
- C. Furnish a copy of all construction documents, addenda, change orders, and approved submittals and shop drawings related to commissioned equipment to the CxA.
- D. Where acceptance testing is to be executed by the system/equipment provider, the Contractor, with the CxA's assistance, will develop final acceptance test checklists for each system, subsystem, or equipment including interfaces and interlocks, and include a separate entry, with space for comments, for each item to be tested. Each checklist, regardless of system, subsystem, or equipment being tested, shall include, but not be limited to, the following:
 1. Name and/or identification of tested item
 2. Time and date of test
 3. Deficiencies with issue number, if any, generated as the result of test

- E. Review commissioning progress and deficiency reports.
- F. Coordinate the resolution of non-compliance and design deficiencies identified in all phases of commissioning.
- G. Assist the CxA as necessary in the deferred testing and deficiency corrections required by the specifications.
- H. Certificate of Readiness shall be provided and signed by Contractor, sub-contractor(s), and installer(s) for each system certifying that all subsystems, equipment, test and balancing, and associated controls are ready for testing. Completed startup plan checklists shall accompany this certificate.
- I. Contractor shall assign representatives with expertise and authority to act on behalf of the Contractor and schedule them to participate in and perform commissioning team activities including, but not limited to, the following:
 - 1. Participate in construction-phase commissioning coordination meetings.
 - 2. Participate in maintenance orientation and observation.
 - 3. Certify that Work is complete and systems are operational according to the Contract Documents, including test and balancing and calibration of instrumentation and controls.
 - 4. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
- J. Subcontractors shall assign representatives with expertise and authority to act on behalf of subcontractors and schedule them to participate in and perform commissioning team activities including, but not limited to, the following:
 - 1. Participate in construction-phase commissioning coordination meetings.
 - 2. Participate in maintenance orientation and observation.
 - 3. Provide information to the CxA for updating construction-phase commissioning plan.
 - 4. Provide updated Project Record Documents to the CxA on a regular basis.
 - 5. Gather and submit operation and maintenance data for systems, subsystems, and equipment to the CM and CxA, as specified in Division 1, Operating Instructions and Service Manual Log.

1.8 CxA'S RESPONSIBILITIES

- A. The CxA is not responsible for design concept, design criteria, compliance with codes, design or general construction scheduling, cost estimating, or construction management. The CxA may assist with problem-solving of non-conformance or deficiencies, but ultimately that responsibility resides with the CM and the A/E. The primary role of the CxA is to develop and coordinate the execution of a testing plan, observe and document performance—that systems are functioning in accordance with the documented design intent and in accordance with the Contract Documents.
- B. At the beginning of the construction phase, an initial construction-phase coordination meeting will be held for the purpose of reviewing the commissioning activities and

establishing tentative schedules for operation and maintenance submittals; TAB Work; and Project completion.

- C. Commissioning team meetings will be held no less frequently than monthly and as frequently as weekly, depending on the current level of commissioning activities. Meetings shall be held for the purpose of coordination, communication, and conflict resolution; discuss progress of the commissioning processes.

1.9 COMMISSIONING DOCUMENTATION

- A. Commissioning Plan: A living document, prepared and maintained by the CxA, that outlines the schedule, allocation of resources, and documentation requirements of the commissioning process, and shall include, but is not limited to the following:
 - 1. Plan for delivery and review of submittals and other documents and reports. Identification of the relationship of these documents to other functions and a detailed description of submittals that are required to support the commissioning processes.
 - 2. Identification of systems and equipment to be commissioned.
 - 3. Description of schedules for testing procedures along with identification of parties involved in performing and verifying tests.
 - 4. Identification of items that must be completed before the next operation can proceed.
 - 5. Description of responsibilities of commissioning team members and listing of contact information for each party.
 - 6. Schedule for commissioning activities to be coordinated with overall construction schedule.
 - 7. Process and schedule for completing prestart and startup and prefunctional checklists for systems, subsystems, and equipment to be verified and tested.
 - 8. Step-by-step procedures for testing systems, subsystems, and equipment with descriptions for methods of verifying relevant data, recording the results obtained, and listing parties involved in performing and verifying tests.
- B. Certificate of Readiness: Certificate of Readiness shall be provided and signed by Contractor, sub-contractor(s), and installer(s) for each system certifying that all subsystems, equipment, and associated controls are ready for testing. Completed startup plan checklists shall accompany this certificate.

1.10 QUALITY ASSURANCE

- A. Test Equipment Calibration: Contractors shall comply with test equipment manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately whenever instruments have been repaired following damage or dropping. Affix calibration tags to test instruments.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 SYSTEMS TO BE COMMISSIONED

- A. See specification sections 230800, Mechanical Commissioning Requirements and 260800, Electrical Commissioning Requirements for lists of systems and equipment to be commissioned.

3.2 STARTUP AND PRE-FUNCTIONAL CHECKLISTS

- A. The following procedures apply to all equipment to be commissioned, according to Section 3.1, Systems to be Commissioned. Some systems that are not comprised so much of actual dynamic machinery, e.g., electrical system power quality, may have very simplified startup plans.
- B. General: Startup and pre-functional checklists are important to ensure that the equipment and systems are hooked up and operational. It ensures that functional performance testing (in-depth system checkout) may proceed without unnecessary delays. Each piece of equipment receives full pre-functional checkout. No sampling strategies are used. The startup and pre-functional checklists for a given system must be successfully completed prior to formal functional performance testing of equipment or subsystems of the given system.
- C. Startup Plan: The CxA shall assist the commissioning team members responsible for startup of any equipment in developing detailed startup plans for all equipment. The primary role of the CxA in this process is to ensure that there is written documentation that each of the manufacturer-recommended procedures have been completed.
 - 1. The contractor responsible for the purchase of the equipment develops the full startup plan by combining (or adding to) the representative checklists and procedures from specifications 230800 and/or 260800 with the manufacturer's detailed startup and checkout procedures from the O&M manual and the normally used field checkout sheets. The plan will include checklists and procedures with specific boxes or lines for recording and documenting the checking and observations of each procedure and a summary statement with a signature block at the end of the plan.
 - 2. The full startup plan could consist of something as simple as:
 - a. The approved startup and checkout procedures and CxA-provided pre-functional checklists.
 - b. The manufacturer's standard written startup procedures copied from the installation manuals with check boxes by each procedure and a signature block added by hand at the end.
 - c. The contractor's normally used field checkout sheets.
 - 3. The contractor submits the full startup plan to the CxA for review and approval.
 - 4. The CxA reviews and approves the procedures and the format for documenting them, noting any procedures that need to be added.
 - 5. The approved startup plan is provided to the Contractor. The Contractor determines which trade is responsible for executing and documenting each of the line item tasks and notes that trade on the form. Each form will have more than one trade responsible for its execution.

D. Execution of Startup Plan

1. Four weeks prior to startup, the Contractors and vendors schedule startup and checkout with the CM and CxA. The performance of the startup plans is directed and executed by the Contractor. When checking off pre-functional checklists, signatures may be required of other Contractors for verification of completion of their work.
2. The Contractors and vendors shall execute the startup and provide the CxA with a signed and dated copy of the completed startup plans.
3. Only individuals that have direct knowledge and witnessed that a line-item task on the startup plan was actually performed shall initial or check that item off. It is not acceptable for witnessing supervisors to fill out these forms.
4. Items left incomplete, which later cause deficiencies or delays during functional testing may result in backcharges to the responsible party.

3.3 FUNCTIONAL PERFORMANCE TESTING

- A. Objectives and Scope: The objective of functional performance testing is to demonstrate that each system is operating according to the documented design intent and Contract Documents. Functional testing facilitates bringing the systems from a state of substantial completion to full dynamic operation. Additionally, during the testing process, areas of deficient performance are identified and corrected, improving the operation and functioning of the systems. In general, each system should be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load) where there is a specified system response. Verifying each sequence in the sequences of operation is required. Proper responses to such modes and conditions as power failure, freeze condition, no flow, equipment failure, etc. shall also be tested.
- B. Development of Test Procedures. Before test procedures are written, the contractor shall provide the CxA with all requested documentation and a current list of change orders affecting equipment or systems, including an updated points list, program code, control sequences and parameters. Using the provided data, the CxA will develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Each Contractor or vendor responsible to execute a test, shall provide limited assistance to the CxA in developing the procedures review (e.g. answering questions about equipment, operation, sequences, etc.). Prior to execution, the CxA shall provide a copy of the test procedures to the Commissioning Team to review for feasibility, safety, equipment and warranty protection. The CxA may submit the tests to the A/E for review, if requested.
- C. Coordination and Scheduling: The Contractor shall provide sufficient notice to the CxA prior to commencement of any equipment/system startup, acceptance testing, observation, demonstrations, or other events which form a part of formal acceptance. The CxA shall direct, witness and document the functional testing of all equipment and systems. The Contractors shall execute the tests. In general, functional testing is conducted after startup has been satisfactorily completed. The air balancing and water balancing is completed and debugged before functional testing of air-related or water-related equipment or systems. Testing proceeds from components to subsystems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems is checked.

- D. Problem Solving. The CxA may recommend solutions to problems found, however the burden of responsibility to solve, correct and retest problems is with the Contractor and A/E.
- E. Opposite Season Testing: Testing procedures shall be repeated and/or conducted as necessary during appropriate seasons. "Opposite season" testing will be required where scheduling prohibits thorough testing in all modes of operation.

3.4 DOCUMENTATION OF NON-CONFORMANCE AND APPROVAL OF TESTS

- A. As tests progress and a deficiency is identified, the CxA discusses the issue with the executing contractor.
 - 1. When there is no dispute on the deficiency and the Contractor accepts responsibility to correct it:
 - a. The CxA documents the deficiency and the Contractor's intentions and testing proceeds.
 - b. Once the Contractor has corrected the deficiency, the CxA shall be notified in writing that the issue has been FIXED certifying that the equipment is ready to be retested.
 - c. The test is repeated and the deficiency status will be changed to either ACCEPTED to close the issue or, if the issue was not properly resolved, the issue status will be will changed back to OPEN.
 - 2. If there is a dispute about a deficiency, regarding whether it is a deficiency or who is responsible:
 - a. The deficiency shall be documented on the project commissioning issues log with the Contractor's response and issued to the Commissioning Team.
 - b. Resolutions are made at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive authority and acceptance authority is with the Owner.
 - c. The CxA documents the resolution process on the project deficiency log.
 - d. Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency and the CxA shall be notified in writing that the issue has been FIXED certifying that the equipment is ready to be retested. The test is repeated until satisfactory performance is achieved.
- B. Cost of Retesting
 - 1. For a deficiency identified, not related to any pre-functional checklist or startup fault, the following shall apply: The equipment will be retested once under the original contract. However, the CxA's time for a second retest will be charged to the Owner, who may choose to recover costs from the Contractor.
 - 2. The time for the CxA to direct any retesting required because a specific pre-functional checklist or startup test item, reported to have been successfully completed, but determined during functional testing to be faulty, will be charged to the Owner, who may choose to recover costs from the Contractor.
 - 3. The Contractor shall respond in writing to the CxA at least as often as commissioning meetings are being scheduled concerning the status of each

apparent outstanding discrepancy identified during commissioning. Discussion shall cover explanations of any disagreements and proposals for their resolution.

4. Any required retesting by any contractor shall not be considered a justified reason for a claim of delay or for a time extension by the Contractor.
- C. Functional Test Approval: The CxA notes each satisfactorily demonstrated function on the test form. Formal approval of the functional test is made later after review by the CxA. The CxA recommends acceptance of each test to the Owner using a standard form. The Owner gives final approval on each test using the same form, providing a signed copy to the CxA and the Contractor.

3.5 DEFERRED TESTING

- A. Unforeseen Deferred Tests: If any check or test cannot be completed due to the building structure, required occupancy condition or other deficiency, execution of checklists and functional testing may be delayed upon approval of the Owner. These tests will be conducted in the same manner as the seasonal tests as soon as possible.

END OF SECTION 019113

TECHNICAL SPECIFICATIONS - UNIVERSAL/HAZARDOUS MATERIALS REMOVAL AND DISPOSAL

For

**UNIVERSITY OF MISSOURI
PROJECT CP24000920
MEDICAL SCIENCE BUILDING
MEDICAL SCHOOL FIRE**

Prepared for

**UNIVERSITY OF MISSOURI
Campus Facilities
Columbia, Missouri 65211**

Prepared by

**UNIVERSITY OF MISSOURI
ENVIRONMENTAL HEALTH & SAFETY**

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PART 1 - GENERAL

Provisions of the General Conditions and Special Conditions are part of this Division.

1.1 WORK COVERED BY CONTRACT DOCUMENTS

- 1.1.1 The Contractor shall inform him/herself of the conditions for the project, and is responsible for verifying the quantities and location of all work to be performed as outlined in this section. Failure to do so shall not relieve the Contractor of his obligation to furnish all materials and labor necessary to carry out the provisions of the Contract. The work of the Contract can be summarized as follows:

The work consists of the proper removal of the following approximate quantities of hazardous materials from Medical Science 7th floor East.

Demolition/Construction Waste

Hazardous Waste

N/A

Universal Waste

Two hundred thirty one (231) four foot fluorescent light bulbs

Eighty five (85) ballasts for fluorescent fixtures

Three (3) exit signs

One (1) emergency fire light

Fourteen (14) door closers

Reclaim/Recycle

Three (3) refrigerator/freezers in the impacted labs must have refrigerant gas evacuated before they are disposed of

NOTE: In M704, there are ten (10) freezers and refrigerators operating.

There is one (1) ice machine operating.

In M705, there are two (2) refrigerators operating.

If they are to be disposed of, they must be evacuated by qualified technicians.

Building Materials Painted with Regulated Heavy Metals

N/A

Radioactive Lab History/Activity

N/A

1.2 **CODES AND REGULATIONS:**

1.1.2.1 All applicable codes, regulations, standards, statutes, laws, and rules have the same force and effect (and are made a part of the contract documents by reference) as if copied directly into the contract documents, or as if published copies are bound herewith. Where conflicts arise, the most stringent specification shall apply.

1.1.2.2 Federal and State requirements which govern universal and hazardous removal work or hauling and disposal of such waste materials include but are not limited to the following:

1.1.2.2.1 U.S. Department of Labor, Occupational Health and Safety Administration (OSHA), 29 CFR 1910 and 29 CFR 1926.

1.1.2.2.1.1 Construction Industry - 29 CFR 1926.1101

1.1.2.2.1.2 Respiratory Protection – 29 CFR 1910.134

1.1.2.2.1.3 Hazard Communication – 29 CFR 1910.1200

1.1.2.2.1.4 Accident Prevention Signs – 29 CFR 1910.145

1.1.2.2.2 U.S. Environmental Protection Agency (EPA)

1.1.2.2.1.5 1.1.3 **CONTRACTOR'S DUTIES**

1.1.3.1 Except as specifically noted, provide and pay for:

- Labor, materials, and equipment.
- Tools, construction equipment, and machinery.
- Other facilities and services necessary for proper execution and completion of work.

1.1.3.2 Pay legally required sales, consumer, use, payroll, privilege, and other taxes. Retail sales tax shall not be included in the bid amount.

1.1.3.3 Secure and pay for, as necessary for proper execution and completion of work, and as applicable at the time of bids:

- Permits
- Government Fees
- Licenses
- Except where specifically noted, provide and pay for waste disposal permits and costs

1.1.3.4 Give required notices.

1.1.3.5 Contractor shall assume full responsibility and liability for compliance with all codes, ordinances, rules, regulations, orders and other legal requirements of Local, State, and Federal public authorities including Environmental Protection Agency (EPA) regulations, Missouri

Department of Natural Resources (MDNR) and Occupational Safety and Health Administration (OSHA) which bear on performance work. Where conflicts occur between these specifications and/or the above-mentioned regulations, the more stringent shall govern. The Contractor shall hold the owner and owner's air monitoring firm harmless for failure to comply with any applicable work, hauling, safety, health, or other regulations on the part of the contractor, contractor's employees, or contractor's subcontractors.

- 1.1.3.6 If the Contractor observes that any of the Contract Documents are at variance therewith in any respect, he shall promptly notify MU in writing, and any necessary changes shall be accomplished by appropriate modification. It is not the Contractor's responsibility to make certain that the Contract Documents are in accordance with applicable laws, statutes, building codes and regulations. If the Contractor performs any work knowing it to be contrary to such laws, ordinances, rules and regulations, and without such notice to MU, he shall assume full responsibility therefore and shall bear all cost attributable thereto.
- 1.1.3.7 Enforce strict discipline and good order among employees. Do not employ unfit persons or persons not skilled in assigned task.
- 1.1.3.8 Comply with all applicable federal, state, and local laws regarding job discrimination and payment of prevailing wage rates for the base bid.
- 1.1.3.9 The use of the best available technology, procedures, and methods for preparation, execution, cleanup, disposal, and safety are absolutely required. This compliance is the sole responsibility of the abatement contractor.
- 1.1.3.10 Assume responsibility for the proper and safe execution of the work.

- 1.1.8 **COORDINATION**: The hazard remediation contractor shall be responsible for the coordination of the universal/hazardous materials removal for this project. The hazard remediation contractor shall coordinate with all other on-site contractors and all subcontractors working under separate contracts so as to facilitate the general progress of the work. Each trade shall afford all trades every reasonable opportunity for the installation of their work.

1.2 STOP WORK

- 1.2.1 If the Owner, or his designated representative, presents a written or verbal stop work order, immediately stop all work or that portion of the work designated. A verbal stop work order shall be confirmed by a written stop work order within 24 hours. Do not commence referenced work until authorized in writing by the Owner or his representative.

1.3 CONTRACTOR USE OF PREMISES

- 1.3.1 **GENERAL:** During the construction period for each building, the hazard remediation contractor will have full access to Medical Science 7th floor East for construction operations. Owner will keep the elevators operational.
- 1.3.2 **USE OF THE SITE:** Confine operations at the site to the areas permitted under the Contract. Portions of the site beyond areas on which work is indicated are not to be disturbed. Conform to site rules and regulations affecting the work while engaged in project construction.
- 1.3.2.1 Keep existing driveways and entrances serving the premises clear and available to the Owner and his employees at all times. Contractor will be allowed to use the parking lot to the north of the building for parking and/or storage of materials.
- 1.3.2.2 Do not unreasonably encumber the site with materials or equipment. Confine stockpiling of materials and location of storage to areas acceptable to Owner. If additional storage is necessary, obtain and pay for such storage off-site.
- 1.3.2.3 Do not load structure with weight that will endanger structure.
- 1.3.2.4 Assume full responsibility for protection and safekeeping of products stored on premises.
- 1.3.2.5 Move any stored products which interfere with operations of Owner or other contractors.
- 1.3.2.6 Contractor personnel shall utilize only those entrances/exits and parking lots designated by the Owner.
- 1.3.2.7 Contractor shall utilize only those areas designated by the Owner for the storage of equipment and the placement of dumpsters/transport containers.
- 1.3.2.8 Take all cautions necessary to ensure there is no universal and hazardous material contamination to those areas not included in work schedule. Should areas outside the work area become contaminated with hazardous materials, the Contractor shall immediately clean them utilizing the wet cleaning and HEPA vacuum methods specified herein. The hazard remediation contractor is responsible for the proper cleanup of all items in the work areas to maintain a clean and safe environment.
- 1.3.3 **CONTRACTOR'S USE OF THE EXISTING BUILDING:** Maintain the existing building in a safe and weather tight condition throughout the construction period. Take all precautions necessary to protect the building and its occupants during the construction period.
- 1.3.3.1 Keep areas such as walkways and stairs free from accumulation of waste material, rubbish or construction debris.
- 1.3.3.2 Smoking or open fires are prohibited within the building or on the

premises.

1.4 OWNER OCCUPANCY

1.4.1 PARTIAL OWNER OCCUPANCY: The Owner reserves the right to occupy areas of the building in which universal/hazardous waste removal has been completed, provided that such occupancy does not substantially interfere with completion of the work. The Owner also reserves the right to occupy portions of the building not involved in this Scope of Work. Such partial occupancy shall not constitute acceptance of the work or any part of the work. The Owner shall also maintain the right to access areas where no universal and hazardous waste work is being performed.

2.1 SUBMITTAL REQUIREMENTS

2.1.1 The following will be submitted by the contractor prior to commencement of work for approval by Owner's Certified Industrial Hygienist (one copy for the Owner's Representative). The Owner's C.I.H. will return reviewed copies to contractor and Owner's Representative.

2.1.1.1 One copy of any Safety Data Sheets (SDS) for products to be used by the contractor in the performance of his work. Contractor will also maintain copies of SDS on site per OSHA.

2.1.2 Submit the following for all Supervisor(s) and Workers who will be on the project site prior to commencement of work:

2.1.2.1 A list of project personnel and contact phone numbers

2.1.2.2 Current training certificates, if applicable

2.1.2.3 Physician's Statement that each person is physically fit to wear a respirator, if respirator use is required

2.1.2.4 Respirator Fit Test, if respirator use is required

2.1.3 Submit a detailed plan of the procedures proposed for use in complying with requirements of this specification. Include in the plan the layout and location of work areas, route of ingress and egress for the work areas, methods used to assure safety of building occupants and visitors, method of removal of material, and disposal container requirements for lead based paint material to be disposed.

2.1.4 Proposed disposal site for lead-based paint materials, including a disposal plan to detail type of disposal container, method of transportation to disposal site, and waste hauler.

2.1.5 Any other submittals as required by MU.

2.1.6 Upon completion of the universal/hazardous material removal, submit to the Owner's Representative, copies of hazardous materials shipping records, disposal receipts, incineration documentation, etc. for all hazardous materials removed from the project site.

2.1.7 Upon completion of the universal waste/hazardous material removal, the following information shall be submitted by the Owner's C.I.H. to the contractor:

2.1.7.1 Construction and demolition waste landfill receipts, disposal receipts, truck tickets, incineration/recycling receipts and documentation.

2.1.7.2 Written visual certification from the Owner's Certified Industrial Hygienist that universal waste/hazardous material have been removed from the facility.

2.2 TERMINOLOGY (Definitions)

2.2.1 **APPROVED Construction and Demolition WASTE DISPOSAL SITE:** A permitted solid waste landfill that is authorized by the Missouri Department of Natural Resources to receive construction and demolition wastes.

2.2.2 **AUTHORIZED VISITOR:** The Building Owner, the Building Owner's representative, MU personnel, or a representative of any regulatory or other agency having jurisdiction over the project.

2.2.3 **BARRIER:** Any surface that seals off the work area to non-authorized personnel from entering the work area.

2.2.4 **BUILDING OWNER:** A representative of the University of Missouri.

2.2.5 **DISPOSAL CONTAINER:** A properly labeled container for universal/hazardous materials. The proposed disposal container for lead-based paint will be provided to the Owner's Representative and part of the hazard remediation contractor's pre-work

2.2.6 **HEPA VACUUM EQUIPMENT:** High efficiency particulate air filtered vacuuming equipment with a filter system capable of collecting and retaining hazardous particulates. Filters should be of 99.97% efficiency for retaining particulates greater than 0.3 microns.

2.2.7 **ON-SITE REPRESENTATIVE:** MU's full-time representative responsible for air monitoring and enforcement of the specifications.

2.2.8 **OWNER'S CERTIFIED INDUSTRIAL HYGIENIST (C.I.H.):** An Industrial Hygienist, certified in comprehensive practice by the American Board of Industrial Hygiene (ABIH).

2.2.9 **HAZARDOUS MATERIAL SHIPMENT RECORD/DISPOSAL RECEIPT:** The shipping document, required to be originated and signed by the waste generator, used to track and substantiate the disposition of universal/hazardous materials.

2.2.10 **WET CLEANING/WIPING:** The process of eliminating contamination from building surfaces and objects by using cloths, mops, or other cleaning tools which have been dampened with water, and by afterwards disposing of these cleaning tools as necessary.

- 2.2.11 **WORK AREA:** A specific isolated area in which universal/hazardous waste materials are required to be handled. The area is designated as a work area from the time that the area is secured and access restrictions are in place. The area remains designated as a work area until the time that it has been cleaned in accordance with any requirements applicable to the operations conducted.

2.3 EXISTING CONDITIONS

- 2.3.1 Building Owner and Contractor shall agree on building conditions prior to commencement of work. It shall be the Contractor's responsibility to replace or repair to the Owner's satisfaction, prior to close-out of the project, all damaged items caused by the Contractor and not proven otherwise. All items damaged prior to remediation shall be noted during preconstruction walk-through.

3.1 PERSONNEL PROTECTION REQUIREMENTS

- 3.1.1 Prior to commencement of work, the workers shall be instructed and shall be knowledgeable on the hazards of the universal hazardous materials involved and other environmental exposures, use and fitting of respirators, protective clothing, decontamination procedures, and all aspects of remediation work procedures; workers shall have medical examinations.
- 3.1.2 The Contractor acknowledges that he alone is responsible for enforcing personnel protection requirements and that these specifications provide only a minimum acceptable standard for each phase of operation.
- 3.1.3 If required or requested of the workers, provide workers with personally issued and marked respiratory equipment approved by NIOSH and accepted by OSHA.
- 3.1.4 No visitors shall be allowed in work areas, except as authorized.
- 3.1.5 Where required or if requested by the workers, provide workers with sufficient sets of disposable protective full-body clothing. Such clothing shall consist of full-body coveralls, footwear, and head gear, one-piece coveralls or equal. Provide eye protection and hard hats as required by applicable safety regulations. Disposable clothing shall not be allowed to accumulate and shall be disposed of as contaminated waste.
- 3.1.6 Provide authorized visitors with suitable protective clothing, headgear, footwear, and gloves as described above whenever they are required to enter the work area.

3.2 MATERIALS

- 3.2.1 Deliver all materials in the original packages, containers, or bundles bearing the name of the manufacturer and the brand name.
- 3.2.1.1 Store all materials subject to damage off the ground, away from wet or damp surfaces, and under cover sufficient to prevent damage or contamination.

3.2.1.2 Damaged or deteriorating materials shall not be used and shall be removed from the premises.

3.2.2 **PLASTIC SHEETING**: A minimum 6-mil (or as specified).

3.2.3 **TAPE**: Capable of sealing joints of adjacent sheets of polyethylene and for attachment of polyethylene sheets to finished or unfinished surfaces of dissimilar materials and capable of adhering under both dry and wet conditions, including use of amended water, duct tape, poly prep tapes or approved equal.

3.2.4 **ADHESIVES**: Capable of sealing joints of adjacent sheets of polyethylene and for attachment of polyethylene sheet to finished or unfinished surfaces of dissimilar materials and capable of adhering under both dry and wet conditions, including use of amended water.

3.2.5 **IMPERMEABLE CONTAINERS**: Suitable to receive and retain any hazardous materials until disposal by the owners rep. The containers shall be labeled as required by owner. Containers must be resistant to damage and rupture.

3.2.6 **WARNING LABELS AND SIGNS**: As required by owner.

3.2.7 **OTHER MATERIALS**: Provide all other materials, such as, but not limited to lumber, plywood, nails, and hardware, which may be required to properly prepare and complete this project.

3.3 TOOLS AND EQUIPMENT

3.3.1 Provide suitable tools for universal/hazardous waste removal and disposal.

3.3.1.1 **Water Sprayer**: Airless or a low pressure sprayer for amended water application as applicable.

3.3.1.2 **Air-Purifying Equipment**: High Efficiency Particulate Air Filtration Systems (HEPA) shall comply with ANSI Z9.2-91. No air movement system or air equipment should discharge particulates outside the work area. Thus, the negative air unit shall be equipped with a three filter bank with the last being the HEPA filter capable of removing 99.97% of fibers/particulates >0.3 microns.

3.3.1.3 **Scaffolding**: As required to accomplish the specified work and meet all applicable safety regulations.

2.3.1.4 **Vacuums**: Use HEPA type from a known manufacturer.

2.3.1.5 Other tools and equipment as necessary.

3.4 SUPERVISION OF UNIVERSAL/HAZARDOUS Material REMOVAL

3.4.1 The contractor shall designate a competent supervisor subject to the approval of the Owner's C.I.H. and the Owner's Representative. The supervisor shall be the Contractor's representative on the project, shall meet the requirements of all applicable regulations, and perform or meet the following minimum requirements:

- 3.4.1.1 Be knowledgeable in all aspects of removal, cleanup and proper disposal of universal hazardous materials as listed in the Scope of Work.
- 3.4.1.2 Be onsite and supervise all removal, cleanup and disposal activities.
- 3.4.1.3 Maintain a daily log on the project documenting events, violations, problems, equipment failures, accidents, and inspections.
- 3.4.1.4 Be responsible for implementation of first aid, safety training, respiratory protection, and ensuring all workers are trained in emergency procedures.
- 3.4.1.5 Be responsible for conducting a visual inspection of the work area prior to a visual inspection by the Owner's Certified Industrial Hygienist. Inspection shall be documented.

3.5 WORKER PROTECTION / TRAINING

- 3.5.1 The contractor shall be responsible for providing his employees with proper respiratory protection, respiratory training, a written respirator program, medical examinations, maintaining medical records, protective clothing and equipment to comply with OSHA requirements, if necessary
- 3.5.2 All workers shall be trained in the dangers inherent in handling universal waste, and hazardous materials, in proper work procedures, and personal protective measures.

3.6 OWNER'S CERTIFIED INDUSTRIAL HYGIENIST

- 3.6.1 It will be the Owner's responsibility to hire a Certified Industrial Hygienist. The Certified Industrial Hygienist will also be required to perform the following duties as a minimum:
 - 3.6.1.1 Approval of the Contractor's work plan and methods of remediation to meet regulatory requirements and ensure the health and safety of University faculty, staff, and students.
 - 3.6.1.2 Verify that the Contractor is satisfactorily performing the work in accordance with OSHA regulations.
 - 3.6.1.3 Visual inspection of the work areas.
 - 3.6.1.4 Certify in writing that the Contractor's procedures, methods, and practices were, to the best of his/her knowledge and belief, in compliance with current EPA, OSHA, State, and Local applicable regulations, that the work areas meet the requirements for a final visual inspection prior to re-occupancy, and an accounting of any known deviations.

3.7 SEPARATION OF WORK AREAS FROM NONWORK AREAS

- 3.7.1 Visual separation shall be accomplished at all "see-through" locations using opaque polyethylene. This separation shall not be incorporated within the other

seals involved on this project.

3.8 EMERGENCY PROTECTION PLAN / FIRE EXITS

- 3.8.1 The contractor shall be responsible for developing a written Emergency Protection Plan and shall maintain this plan onsite. The plan shall include considerations of fire, explosion, toxic atmospheres, electrical hazards, slips, falls, and heat related injury. All employees shall be instructed and trained in the procedures.
- 3.8.2 The Emergency Protection Plan shall also include written notification of police, fire, and medical personnel of the planned remediation activities, work schedule, and layout of the work area, particularly barriers that may affect response capabilities.
- 3.8.3 Designate and maintain emergency and fire exits from the work area in accordance with local codes and regulations. All exits shall be clearly marked with fluorescent tape or red paint and shall be clearly visible from any part of the work area.

3.9 LOCAL AREA PROTECTION / SITE SECURITY

- 3.9.1 The contractor shall secure the work areas to make sure of no inadvertent entry. Any breach to the exterior of the building shall be secured by the hazard remediation contractor. The Contractor shall be responsible for maintaining security of the remediation areas throughout the contract period.
- 3.9.2 The contractor shall be responsible for all areas of the building used by contractor and/or subcontractors in the performance of the work. Contractor shall exert full control over the actions of all employees and other persons with respect to the use and preservation of the existing building, except such controls as may be specifically reserved to the owner.
- 3.9.3 Contractor has the right to exclude from the work area all persons who have no purpose related to the work or its inspection, and shall require all persons in the work area to observe the same regulations required of Contractor's employees.
- 3.9.4 The contractor shall have control of site security during remediation operations in order to protect the work environment and equipment. Contractor shall have the owner's assistance in notifying building occupants of impending activity and enforcement of restricted access by owner's employees.
- 3.9.5 The contractor shall keep a minimum of two (2) 10lb type ABC fire extinguishers onsite. One shall be maintained outside the work area and one inside each work area. Contractor employees shall be trained in the operation of fire extinguishers.
- 3.9.6 The contractor shall maintain the work area free from rubbish, debris, and dirt, and keep a clean, safe working area.

3.10 UNIVERSAL WASTE/HAZARDOUS MATERIALS REMOVAL OPERATIONS

- 3.10.1 Any light fixtures, housings, etc. concealing items considered to be universal waste/hazardous material shall be removed, containerized, labelled, and left on site for disposal by MU EHS. This does not include refrigerant or CHC/HCFC-containing equipment which are being replaced by the contractor. It does not include TCLP ceramic tile, which should be handled by the contractor.
- 3.10.2 **MATERIALS PAINTED WITH RCRA-Metals PAINT –**
It is anticipated that these items will be removed as part of the demolition process and will be segregated from the remainder of the demolition debris. It is anticipated that these items will be hauled away and disposed of in a sanitary landfill approved by the State of Missouri to accept construction and demolition waste. These areas should be sealed off with polyethylene sheeting over the doors, vents, windows, or any other openings into/out of the area.
- 3.10.3 **FLUORESCENT LIGHT TUBES** may contain small amounts of Mercury. This can potentially be harmful to human health and the environment. The bulbs should be placed in fiberboard boxes provided by MU EHS to minimize breakage. MU EHS will manage disposal of this material.
- 3.10.4 **POLYCHLORINATED BIPHENYL (PCBS)** are a known carcinogenic material. Its use was discontinued January 1, 1979. Due to the age of the building, it should be assumed that any ballast can contain PCBs unless it is labeled as PCB free by the manufacturer. Due to this, any light ballasts presumed to contain PCBs should be properly disposed of. MU Environmental Health and Safety will provide collection container for this purpose. Non-PCB ballasts will also be managed by MU Environmental Health and Safety. Collection containers will be provided to the contractor upon their request.
- 3.10.5 **SMOKE DETECTORS** are typically ionization smoke detectors that may contain a small amount of radioactive material. MU Environmental Health and Safety will provide collection containers for this material and will also be responsible for the disposal of this material.
- 3.10.6 **FIRE ALARMS (STROBE LIGHT)** are typically not considered a universal or hazardous waste. However, for the purposes of this project, these items should be collected by the contractor and managed by MU Environmental Health and Safety. Collection containers will be provided to the contractor upon their request.
- 3.10.7 **EXIT SIGNS AND EMERGENCY LIGHTS** typically have backup batteries that may contain small amounts of lead. Some exit signs are powered by a small

amount of radioactive material. Powered exit signs and emergency lights should have the battery removed and disposed of by MU Environmental Health and Safety. Non powered exit signs should be assumed to contain radioactive material and should be collected for disposal via MU Environmental Health and Safety. MU Environmental Health and Safety will provide collection containers for these items.

- 3.10.8 **DRINKING FOUNTAINS**: Some drinking fountains have reservoirs that may contain lead and a CFC/HCFC refrigerant that must be recovered. The lead reservoirs should be removed and recycled. The CFC/HCFC refrigerant must be recovered by a contractor licensed and trained in this type of work. The remainder of the unit should be managed as scrap metal.
- 3.10.9 **DOOR CLOSURES**: Some of the older door closures have oil reservoirs for lubrication. These oils may contain small amounts of PCBs. MU Environmental Health and Safety will provide a collection container for this material, and will be responsible for disposal.
- 3.10.10 **THERMOSTATS** may contain Mercury. This can potentially be harmful to human health and the environment. Mercury containing thermostats shall be disposed of as a hazardous waste. MU EHS will provide a collection container for this material, and will be responsible for disposal.
- 3.10.11 **WINDOW AIR CONDITIONING UNITS**: Where possible, these window units should be removed and stored for use elsewhere. Otherwise these units may contain CFC/HCFC refrigerants that must be recovered. CFC/HCFC refrigerants are suspected to damage the atmosphere. The CFC/HCFC refrigerant must be recovered by a contractor licensed and trained in this type of work. The remainder of the unit should be managed as scrap metal.

3.12 REESTABLISHMENT OF THE WORK AREA

- 3.1-2.1 Reestablishment of the work area shall only occur after the Contractor has received a final visual inspection from the Owner's C.I.H. documenting that the universal/hazardous waste materials have been removed from the project site.

END OF SECTION

SECTION 024119 - SELECTIVE DEMOLITION

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. Demolition and removal of selected portions of building or structure.
 - 2. Salvage of existing items to be reused or recycled.
- B. Related Requirements:
 - 1. Existing Hazardous Material information provided by Owner.
 - 2. Sections 020810 "Universal/Hazardous Materials Removal and Disposal" as provided by University of Missouri Environmental Health & Safety

1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.
- B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse.
- C. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.
- D. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.

1.5 PREINSTALLATION MEETINGS

- A. Pre-demolition Conference: Conduct conference at Project site.
 - 1. Inspect and discuss condition of construction to be selectively demolished.
 - 2. Review structural load limitations of existing structure.
 - 3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
 - 4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
 - 5. Review areas where existing construction is to remain and requires protection.
 - 6. List existing utilities in each demolition zone that are to remain in operation or are to be removed.
 - a. Confirm with Owner that utility items to be removed do not serve other areas, have been planned to be taken off-line, or have been replaced by other services.

1.6 INFORMATIONAL SUBMITTALS

- A. Proposed Protection Measures: Submit report, including drawings, that indicates the measures proposed. Indicate proposed locations and construction of barriers.
 - 1. Proposed Dust-Control and Noise-Control Measures: Submit statement or drawing that indicates the measures proposed for use, proposed locations, and proposed time frame for their operation. Identify options if proposed measures are later determined to be inadequate.
 - 2. Indicate proposed locations and construction of barriers.
 - 3. Secure, 1-hour fire-rated partitions are required to separate demolition and construction zones from occupied areas.
 - 4. Egress paths as indicated need to be maintained during construction.
 - 5. Work that requires disruption to egress paths (as indicated) shall be done at scheduled times/days when building occupants are minimal and/or segregated from the work area in a manner approved by the Owner and the Architect.
- B. Schedule of Selective Demolition Activities: Indicate the following:
 - 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
 - 2. Interruption of utility services. Indicate how long utility services will be interrupted. Obtain Owner's permission in writing prior to interrupting services as noted in the Special Conditions.
 - 3. Coordination for shutoff, capping, and continuation of utility services.

4. Use of elevator and stairs. Allow for Owner's continuing use of service elevator.
 5. Locations of temporary partitions and means of egress.
 6. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
 7. Secure, 1-hour fire-rated partitions are required to separate demolition and construction zones from occupied areas.
 8. Egress paths as indicated need to be maintained during construction.
 9. Work that requires disruption to egress paths (as indicated) shall be done at scheduled times/days when building occupants are minimal and/or segregated from the work area in a manner approved by the Owner and the Architect.
- C. Pre-demolition Photographs or Video: Submit before Work begins. Include areas below the project area.
- D. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

1.7 QUALITY ASSURANCE

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

1.8 FIELD CONDITIONS

- A. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
1. Before selective demolition, As far as practicable, Owner will remove items that are desired:
 2. Coordinate with Owner any remaining items to be salvaged.
- B. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- C. Asbestos Materials: Asbestos materials are present in buildings and structures to be selectively demolished. A report on the presence of Asbestos materials is provided by the owner within the project manual for review and use. Examine report to become aware of locations where asbestos materials are present.
1. Asbestos material remediation is the responsibility of the owner.
 2. Schedule work near known asbestos material to allow coordination with owner's asbestos removal team. Notify owner in advance of need for removal of asbestos material so as not to affect schedule.
 3. Do not disturb asbestos materials or items suspected of containing asbestos materials except under procedures specified elsewhere in the Contract Documents.
 4. Owner will provide material safety data sheets for suspected asbestos materials that are known to be present in buildings and structures to be selectively demolished because of building operations or processes performed there.
- D. Storage or sale of removed items or materials on-site is not permitted.
- E. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
1. Maintain fire-protection facilities in service during selective demolition operations or provide 24 hour fire watch.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

2.2 REPAIR MATERIALS

- A. Use repair materials identical to existing materials.
1. If identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.
 2. Use materials whose installed performance equals or surpasses that of existing materials.
- B. Comply with material and installation requirements specified in individual Specification Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.
- B. Review record documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in record documents.

- C. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.
- E. Survey of Existing Conditions: Record existing conditions by use of measured drawings preconstruction photographs, and preconstruction video recordings.
 - 1. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
- B. Existing Services/Systems to Be Removed or Relocated: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.
 - 1. Do not close, shut off, or disrupt existing utility branches or take offs that are in use without at least 7 days prior written notification to Owner's Representative.
 - 2. If services/systems are required to be removed or relocated, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
 - 3. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated to be removed and or in conflict with new work.
 - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material. **Only abandon piping in place where specifically indicated.**
 - c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
 - f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
 - g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material. **Only abandon ducts in place where specifically indicated.**
- C. Refrigerant: Remove refrigerant from mechanical equipment to be selectively demolished according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 PREPARATION

- A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
- B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
 - 1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
 - 2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
 - 3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
 - 4. Provide, erect, and maintain temporary dust barriers and security devices.
 - 5. Use physical barriers to prevent access to areas that could be hazardous to workers or the public.
 - 6. Conduct operations to minimize effects on and interference with adjacent spaces and occupants.

3.4 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
 - 1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.

2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
 3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 4. The use of cutting torches is to be avoided. In the event that cutting torches are required, Notify Owner a minimum of 3 days prior to operation. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations. Avoid use of hot work where possible. Maintain adequate ventilation when using cutting torches. Hot work permits may be required.
 5. When fire protection system is out of service, provide 24 hour fire on-site watch and work to repair immediately. Fire watch personnel shall be provided with at least one approved means for notification of the fire department and their sole duty shall be to perform constant patrols and watch for occurrence of fire.
 6. Services (including but not limited to HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications): Remove existing systems and equipment as indicated.
 - a. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components.
 - b. 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.
 - c. Verify that abandoned services serve only abandoned facilities before removal.
 - d. 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.
 7. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 8. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
 9. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
 10. Dispose of demolished items and materials promptly. Comply with requirements in Special Conditions.
- B. Removed and Salvaged Items:
1. Clean salvaged items.
 2. Store items in a secure area until delivery to Owner.
 3. Transport items to Owner's storage area as designated by Owner.
- C. Removed and Reinstalled Items:
1. Clean and repair items to functional condition adequate for intended reuse.
 2. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
- D. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition.

3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

- A. Concrete: Demolish in small sections. Using power-driven saw, cut concrete full depth at junctures with construction to remain and then remove concrete between saw cuts.
- B. Roofing: Remove no more existing roofing than what can be covered in one day by new roofing and so that building interior remains watertight and weathertight. See Section 070150 "Roofing Patch and Repair" for roofing modification requirements.

3.6 PATCHING AND REPAIRS

- A. General: Where possible, promptly repair damage to adjacent construction caused by selective demolition operations.

3.7 DISPOSAL OF DEMOLISHED MATERIALS

- A. General: Except for items or materials indicated to be recycled, reused or salvaged, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.
1. Do not allow demolished materials to accumulate on-site.
 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- B. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

- C. Coordinate disposal of items listed in Sections 020810 "Universal/Hazardous Materials Removal and Disposal" with Owner.

3.8 CLEANING

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

END OF SECTION 024119

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SECTION 025100 – PHYSICAL DECONTAMINATION

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.
- B. ANSI/IICRC S700 Standard for Professional Fire and Smoke Damage Restoration

1.2 SUMMARY

- A. Section Includes the cleaning, decontamination, and restoration of existing surfaces to pre-loss conditions by effective fire residue removal and odor management procedures, and the preparation of existing surfaces for repair by other trades where indicated.
- B. This Section applies to Base Bid Option 'L' only. Existing construction impacted by the incident is indicated to be removed entirely in Base Bid Option 'M'.

1.3 DEFINITIONS

- A. Clean: To remove residues or contaminants caused by a specific incident to a degree sufficient for the proper application of sealer, primer, paint, or other finish coatings, OR to a degree sufficient to restore existing in-place finishes to their original condition prior to the incident without applying new finishes. This is separate from and in addition to final cleaning performed by the General Contractor at substantial completion of the project.
- B. Fire and Smoke Damage: An alteration from a pre-event state that results in the loss of appearance, utility, or value because of the impact of heat from fire, fire residues and related odors on building surfaces, materials and items.
- C. Fire Residue: A soiling, odorous and potentially damaging substance transported as a component of smoke which deposits on or adheres to surfaces in its path of movement.
- D. Like Kind and Quality: Equivalent in type, function, and value, but not identical to another item.
- E. Remove and Reinstall: Detach items from existing construction, clean substrates thoroughly, and reinstall in the original location.
- F. Sealer (or Shellac): An odor management product that can also be used as a primer to cover discoloration in the surface to which the sealer is applied. The purpose of a sealer in fire and smoke damage restoration is to cover heat and smoke discoloration and to block the transmission of odors. Sealers may serve as a primer for final finishes, or may serve as a final treatment in concealed locations.

1.4 QUALITY ASSURANCE

- A. All work under this Section shall be performed by a qualified Fire and Smoke Damage Restoration Contractor who is:
 - 1. Proficient in the identification, evaluation, and restoration of fire and smoke-related damage, with specialized knowledge and expertise in effective treatments and techniques that specifically address fire and smoke damage.
 - 2. Licensed to provide restoration services in the State of Missouri.
 - 3. Appropriately insured as required by the Authority Having Jurisdiction.

1.5 FIELD CONDITIONS

- A. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- B. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with restoration activities.
- C. Hazardous Materials: Hazardous materials may be present in buildings and structures to be restored. A report on the presence of Hazardous materials is provided by the Owner within the project manual for reference. Examine report to become aware of locations where hazardous materials are present.
 - 1. Hazardous material remediation is the responsibility of the Owner.
 - 2. Schedule work near known hazardous material to allow coordination with Owner's hazardous material abatement team. Notify Owner in advance of need for removal of hazardous material so as not to affect schedule.
 - 3. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents.
 - 4. Owner will provide material safety data sheets for suspected hazardous materials that are known to be present in buildings and structures to be restored because of building operations or processes performed there.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. All products utilized in performing the work under this Section shall be consistent with recommendations found in the current edition of ANSI/IICRC S700 Standard for Professional Fire and Smoke Damage Restoration.

2.2 REPAIR MATERIALS

- A. Use repair materials identical to existing materials where possible.
 - 1. If identical materials are unavailable or cannot be used for exposed surfaces, use materials of Like Kind and Quality and that visually match existing adjacent surfaces.
 - 2. Use materials whose installed performance equals or surpasses that of existing materials.
 - 3. Use materials that are compatible with, and recommended for installation over the substrates to which they are applied.
- B. Comply with material and installation requirements specified in individual Specification Sections.

PART 3 - EXECUTION

3.1 PERFORMANCE REQUIREMENTS

- A. All work under this Section shall be completed in accordance with recommendations found in the current edition of ANSI/IICRC S700 Standard for Professional Fire and Smoke Damage Restoration.

3.2 EXAMINATION

- A. Review record documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are the same as those indicated in record documents.
- B. Survey existing conditions and correlate with requirements indicated to determine extent of restoration required.

3.3 DOCUMENTATION

- A. Survey of Existing Conditions: Record existing conditions by use of digital photographs prior to beginning work for comparison in evaluating results of remediation activities.
- B. Survey of Restored Conditions: Record restored conditions by use of digital photographs after restoration activities are complete to demonstrate successful remediation.

3.4 RESTORATION PROCEDURES, GENERAL

- A. Utilize the most appropriate methods, tools, and cleaning products available to effectively remove fire residue, including mechanical (dry) processes, liquid (wet) processes, or both.
 - 1. Utilize the least aggressive process available to effectively restore a given surface without adversely affecting the material being treated.
 - 2. Use of liquid cleaning processes should be performed after evaluation of the target surface and progressively increasing the level of aggressiveness until desired results are obtained.
 - 3. To determine which dry or liquid method is to be used, test various products for their effectiveness.
 - 4. On porous and semi-porous materials and surfaces, wet processes may be used only after mechanical dry processes have been performed and determined to not achieve desired results.
 - 5. Sealers should only be applied after surfaces have been thoroughly cleaned, to the extent feasible.
 - 6. Sealers should be applied in sufficient quantities to create a continuous, non-permeable membrane over the surface indicated. More than one application may be required for satisfactory results.
- B. Removed and Reinstalled Items:
 - 1. Carefully remove, store, and reinstall items where indicated. Protect removed items from damage while restoration activities are being completed.
 - 2. Clean and repair items to functional condition adequate for intended reuse prior to reinstallation.
 - 3. Reinstall items in their original location unless otherwise indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for its intended use.
- C. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during restoration.

3.5 RESTORATION SCOPE SUMMARY BY ROOM

#	ROOM	DESCRIPTION
10	GENERAL CONDITIONS	Disinfect building - fog / spray
11	GENERAL CONDITIONS	Cleaning Technician - clean exterior of duct work and pipes*
12	GENERAL CONDITIONS	Clean the walls and ceiling - Heavy
13	GENERAL CONDITIONS	Clean floor - Heavy
17	M712	Seal the ceiling shellac - one coat
21	M712	Clean floor, strip & wax
25	M712	Clean the ceiling - Heavy
26	M712	Clean the walls
27	M712	Clean floor
37	M704	Seal the ceiling shellac - one coat
40	M704	Clean stud wall
42	M704	Epoxy finish - one coat over concrete floor
54	M705	Seal the ceiling shellac - one coat
58	M705	Clean stud wall
60	M705	Clean floor, strip & wax
65	M705	Clean sink
66	M705	Clean cabinetry - upper - inside and out
67	M705	Clean cabinetry - lower - inside and out
74	M711	Seal the ceiling shellac - one coat
78	M711	Clean stud wall
94	M706 Research Lab	Seal the ceiling shellac - one coat
100	M706 Research Lab	Clean stud wall
107	M706 Research Lab	Seal the ceiling shellac - one coat
114	M710A	Seal the ceiling shellac - one coat
117	M710A	Clean stud wall
119	M710A	Epoxy finish - one coat over concrete floor
137	M710	Seal the ceiling shellac - one coat
141	M710	Clean stud wall
143	M710	Epoxy finish - one coat over concrete floor
151	M710	Detach & Reset Cabinetry - lower (base) units
152	M710	Detach & Reset 4" backsplash for flat laid countertop
153	M710	Detach & Reset Cabinetry - upper (wall) units
154	M710	Detach & Reset Watersaver Laboratory Sink faucet *
155	M710	Detach & Reset P-trap assembly - ABS (plastic)
156	M710	Detach & Reset Sink - single
165	M710B	Seal the ceiling shellac - one coat
169	M710B	Clean stud wall
171	M710B	Epoxy finish - one coat over concrete floor
185	M707	Seal the ceiling shellac - one coat
192	M707	Clean stud wall
205	M707A	Seal the ceiling shellac - one coat
210	M707A	Clean stud wall
231	M708A1 VEST.	Seal the ceiling shellac - one coat
235	M708A1 VEST.	Clean stud wall
237	M708A1 VEST.	Clean floor, strip & wax
245	M708A4	Seal the ceiling shellac - one coat
247	M708A4	Shelving - Detach & reset
249	M708A4	Clean stud wall

262	M708A3	Clean part of the walls
264	M708A3	Epoxy finish - one coat over concrete floor
286	M708A3	Seal the ceiling shellac - one coat
297	M708A2	Seal the ceiling shellac - one coat
305	M708A2	Epoxy finish - one coat over concrete floor
333	M708A	Clean the walls and ceiling
334	M708A	Clean floor, strip & wax
368	M708A	Seal the ceiling shellac - one coat
375	M708 Research Lab	Clean the walls and ceiling
376	M708 Research Lab	Clean floor, strip & wax
408	M708 Research Lab	Seal the ceiling shellac - one coat
409	M708 Research Lab	Seal the ceiling shellac - one coat
420	M708B	Clean the walls and ceiling
421	M708B	Clean floor, strip & wax
440	M708B	Seal the ceiling shellac - one coat
452	M708B2	Clean the walls and ceiling
453	M708B2	Clean floor, strip & wax
474	M708B2	Seal the ceiling shellac - one coat
477	Storage Area/Room	Clean the walls and ceiling
479	Subroom: Landing (2)	Clean the walls and ceiling
486	Corridor M709	Seal the ceiling shellac - one coat
491	Corridor M709	Clean the walls and ceiling - Heavy
499	Stairway	Clean the walls and ceiling
501	Stairs1 (Opens to Stairway2 and Landing1)	Clean the walls and ceiling
508	Corridor M727	Seal the ceiling shellac - one coat
512	Corridor M727	Clean floor, strip & wax
513	Corridor M727	Clean the walls and ceiling
516	M718 Research Lab	Clean the walls and ceiling
517	M713	Clean the walls and ceiling
520	M726	Seal the ceiling shellac - one coat
522	M726	Seal the walls shellac - one coat
523	M726	Concrete sealer - brush or spray applied
527	Men's Restroom	Clean the walls and ceiling
528	Women's Restroom	Clean the walls and ceiling
532	M702 Research Lab	Seal the ceiling shellac - one coat
537	M702 Research Lab	Clean floor, strip & wax
548	M723	Seal the ceiling shellac - one coat
552	M723	Clean floor, strip & wax
564	M625	Clean floor, strip & wax
568	M609	Shelving - Detach & reset
578	M605	Clean floor, strip & wax
591	M607 Biology Lab	Clean floor, strip & wax
596	M607C	Shelving - Detach & reset
599	M607C	Clean floor, strip & wax
607	M607B	Clean floor, strip & wax
613	M413	Detach & Reset Fluorescent - four tube - 4' - fixture w/lens
618	M413	Shelving - Detach & reset

END OF SECTION 025100

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Design Mixtures: For each concrete mixture.
- C. Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement.

1.3 INFORMATIONAL SUBMITTALS

- A. Material certificates.
- B. Material test reports.
- C. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer, detailing fabrication, assembly, and support of formwork.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
 - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- B. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1.5 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on concrete mixtures.

1.6 FIELD CONDITIONS

- A. Cold-Weather Placement: Comply with ACI 306.1.
 - 1. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- B. Hot-Weather Placement: Comply with ACI 301 .

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

- A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
 - 1. ACI 301 .
 - 2. ACI 117 .

2.2 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
- B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

2.3 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 , deformed.
- B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.
- C. Plain-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, plain, fabricated from as-drawn steel wire into flat sheets.
- D. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice."

2.4 CONCRETE MATERIALS

- A. Cementitious Materials:
 - 1. Portland Cement: ASTM C 150/C 150M, Type I/II.
 - 2. Fly Ash: ASTM C 618, Class C.

- B. Normal-Weight Aggregates: ASTM C 33/C 33M, graded.
 - 1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
 - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Air-Entraining Admixture: ASTM C 260/C 260M.
- D. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
 - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 - 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
- E. Water: ASTM C 94/C 94M and potable.

2.5 CURING MATERIALS

- A. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

2.6 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301 .
- B. Cementitious Materials: Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.
- C. Admixtures: Use admixtures according to manufacturer's written instructions.
 - 1. Use water-reducing, high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
 - 2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 - 3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a w/c ratio below 0.50.

2.7 CONCRETE MIXTURES FOR BUILDING ELEMENTS

- A. Normal-Weight Concrete:
 - 1. Minimum Compressive Strength: 4000 psi at 28 days.
 - 2. Maximum W/C Ratio: 0.45.
 - 3. Slump Limit: 4 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch .

2.8 FABRICATING REINFORCEMENT

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

2.9 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M, and furnish batch ticket information.
 - 1. When air temperature is between 85 and 90 deg F , reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F , reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK INSTALLATION

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301 , to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 .
- C. Chamfer exterior corners and edges of permanently exposed concrete.

3.2 EMBEDDED ITEM INSTALLATION

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.3 STEEL REINFORCEMENT INSTALLATION

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
 - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

3.4 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.
- B. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
 - 1. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301 .

3.5 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - 1. Apply to concrete surfaces not exposed to public view.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - 1. Apply to concrete surfaces exposed to public view, to receive a rubbed finish, or to be covered with a coating or covering material applied directly to concrete.
- C. Rubbed Finish: Apply the following to smooth-formed-finished as-cast concrete where indicated:
 - 1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
 - 2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix 1 part portland cement to 1-1/2 parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
 - 3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix 1 part portland cement and 1 part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.
- D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.6 FINISHING FLOORS AND SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in one direction.
 - 1. Apply scratch finish to surfaces indicated and to receive concrete floor toppings to receive mortar setting beds for bonded cementitious floor finishes.
- C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture.
 - 1. Apply float finish to surfaces to receive trowel finish and to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.
- D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
 - 1. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.

2. Finish and measure surface, so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.- long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/8 inch .
 - E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thinset method. While concrete is still plastic, slightly scarify surface with a fine broom.
 1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.
 - F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.
 1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.
- 3.7 CONCRETE PROTECTING AND CURING**
- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
- 3.8 CONCRETE SURFACE REPAIRS**
- A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- 3.9 FIELD QUALITY CONTROL**
- A. Special Inspections: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

END OF SECTION 033000

SECTION 033511- CONCRETE FLOOR FINISHES

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 surface treatments for concrete floors and slabs as indicated on finish schedule.
- B. Related Requirements
 - 1. Cast-in-Place Concrete See structural drawings for concrete information.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the work with concrete floor placement and concrete floor curing.

1.4 SUBMITTALS

- A. See Section 013300 – Submittal Procedures, for submittal procedures.
- B. Product Data: Manufacturer's published data on each finishing product, including information on compatibility of different products and limitations.
- C. Maintenance Data: Provide data on maintenance and renewal of applied finishes.

1.5 FIELD CONDITIONS

- A. Maintain light level equivalent to a minimum 200 W light source at 8 feet above the floor surface over each 20 foot square area of floor being finished.
- B. Do not finish floors until interior heating system is operational.
- C. Maintain ambient temperature of 50 degrees F minimum.

PART 2 - PRODUCTS

2.1 CONCRETE FLOOR FINISH APPLICATIONS

- A. **SC-1:** water-based sealer: Unless otherwise indicated, all concrete floors not receiving other coverings or treatment are to be finished using liquid SC-1 sealer. This includes housekeeping/janitorial rooms, mechanical rooms, electrical rooms and storage rooms.

2.2 SEALERS

- A. **SC-1:** Liquid transparent, chemically reactive, water-based sealer: Penetrating chemical compound that reacts with concrete, filling the pores and dustproofing; for application to concrete prior to set. Minimum one coat required, comply with manufacturer's minimum number of coats.
 - 1. Composition: Sodium silicate.
 - 2. Products:
 - a. CureCrete Chemicals, Inc.; Ashford Formula
 - b. L&M Construction Chemicals, Inc.; Chem-Hard: www.lmcc.com.
 - c. W.R. Meadows, Inc; Liqui-Hard: www.wrmeadows.com.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that floor surfaces are acceptable to receive the work of this section.
- B. Verify that flaws in concrete have been patched and joints filled with methods and materials suitable for further finishes.

3.2 GENERAL

- A. Apply materials in accordance with manufacturer's instructions.

3.3 PREPARATION

- A. Surface to be treated must be clean, dry and well cured.
 - 1. Remove dirt, oil, grease, paint, waxes, with cleaners.
 - 2. Remove efflorescence and surface sealers with manufacturer's recommended stripping materials.

3.4 COATING APPLICATION

- A. Verify that surface is free of previous coatings, sealers, curing compounds, water repellents, laitance, efflorescence, fats, oils, grease, wax, soluble salts, residues from cleaning agents, and other impediments to adhesion.
- B. Verify that water vapor emission from concrete and relative humidity in concrete are within limits established by coating manufacturer.

- C. Protect adjacent non-coated areas from drips, overflow, and overspray; immediately remove excess material.
- D. Apply coatings in accordance with manufacturer's instructions.
- E. Application:
 - 1. SC-1: apply minimum of one coat using methods recommended by manufacturer.

END OF SECTION 033511

SECTION 042200 - CONCRETE UNIT MASONRY

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: Repair and infill of existing CMU walls.
 - 1. Concrete masonry units.
 - 2. Mortar and grout.
 - 3. Steel reinforcing bars.
 - 4. Masonry-joint reinforcement.

1.3 DEFINITIONS

- A. CMU(s): Concrete masonry unit(s).

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

- A. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
 - 1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91/C 91M for air content.
 - 2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.
- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.7 FIELD CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
 - 1. Extend cover a minimum of 24 inches down both sides of walls, and hold cover securely in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
 - 1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
 - 2. Protect sills, ledges, and projections from mortar droppings.
 - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 - 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- D. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations for Masonry Units: Obtain masonry units from single source from single manufacturer for each product required.
- B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

2.2 UNIT MASONRY, GENERAL

- A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6 except as modified by requirements in the Contract Documents.
- B. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.
 - 1. Where fire-resistance-rated construction is indicated, units shall be listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction.

2.3 CONCRETE MASONRY UNITS

- A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
 - 1. Bullnose Corners: Provide bullnose vertical corners full height at all exposed outside corners whether shown on drawings or not.
 - 2. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
 - 3. Provide square-edged units for outside corners unless otherwise indicated.
- B. CMUs: ASTM C 90.
 - 1. Density Classification: Lightweight .
 - 2. Size (Width): See drawings for sizes of walls.

2.4 CONCRETE MASONRY LINTELS

- A. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs matching adjacent CMUs in density classification, with horizontal reinforcing bars placed as indicated and filled with coarse grout. If reinforcing bars are not indicated, provide prefabricated lintel or #5 bars in field fabricated lintel. Temporarily support built-in-place lintels until cured.

2.5 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C 150/C 150M, Type I or II.
 - 1. Alkali content shall not be more than 0.1 percent when tested according to ASTM C 114.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- D. Aggregate for Mortar: ASTM C 144.
 - 1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
 - 2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
- E. Aggregate for Grout: ASTM C 404.
- F. Water: Potable.

2.6 TIES AND ANCHORS

- A. Partition Top Anchors: 0.105-inch- thick metal plate with a 3/8-inch- diameter metal rod 6 inches long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from [steel, hot-dip galvanized after fabrication] [stainless steel].

2.7 REINFORCEMENT

- A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.
 - 1. For use as horizontal and vertical reinforcing as well as doweling into slab.
- B. Masonry-Joint Reinforcement, General: Ladder type complying with ASTM A 951/A 951M.
 - 1. Interior Walls: Mill- galvanized carbon steel.
 - 2. Wire Size for Side Rods: 0.148-inch diameter.
 - 3. Wire Size for Cross Rods: 0.148-inch diameter.
 - 4. Spacing of Cross Rods: Not more than 16 inches o.c.
 - 5. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units].
- C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.

2.8 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
 - 1. Do not use calcium chloride in mortar or grout.
 - 2. Use portland cement-lime mortar unless otherwise indicated.
 - 3. For reinforced masonry, use portland cement-lime mortar.
- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- C. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
 - 1. For reinforced masonry, use Type S.
- D. Grout for Unit Masonry: Comply with ASTM C 476.
 - 1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
 - 2. Proportion grout in accordance with ASTM C 476, Table 1.
 - 3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
 - 2. Verify that foundations are within tolerances specified.
 - 3. Verify that reinforcing dowels are properly placed.
 - 4. Verify that substrates are free of substances that would impair mortar bond.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Build chases and recesses to accommodate items specified in this and other Sections.
- B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.
- C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

3.3 TOLERANCES

- A. Dimensions and Locations of Elements:
 - 1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch or minus 1/4 inch.
 - 2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch.
 - 3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.
- B. Lines and Levels:
 - 1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 feet, or 1/2-inch maximum.
 - 2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2-inch maximum.
 - 3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2-inch maximum.
 - 4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2-inch maximum.
 - 5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2-inch maximum.
 - 6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2-inch maximum.

7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch.
- C. Joints:
 1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
 2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
 3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
 4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.

3.4 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.
- C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4 inches. Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.
- D. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.
- E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.
- G. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.
- H. Build nonload-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.
 1. Wedge nonload-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.
 2. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 078443 "Joint Firestopping."

3.5 MORTAR BEDDING AND JOINTING

- A. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
- B. Cut joints flush where indicated to receive waterproofing or resinous coating unless otherwise indicated.

3.6 MASONRY-JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with equal cover on either side of walls. Lap reinforcement a minimum of 6 inches.
 1. Space reinforcement not more than 16 inches o.c.
 2. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.
- B. Provide continuity at wall intersections by using prefabricated T-shaped units.
- C. Provide continuity at corners by using prefabricated L-shaped units.
- D. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.7 LINTELS

- A. Provide masonry lintels where shown and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels.
- B. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

3.8 REINFORCED UNIT MASONRY INSTALLATION

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
 1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
 2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

- B. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
 - 1. Comply with requirements in TMS 602/ACI 530.1/ASCE 6 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
 - 2. Limit height of vertical grout pours to not more than 60 inches 12.67 ft.

3.9 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

3.10 MASONRY WASTE DISPOSAL

- A. Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

END OF SECTION 042200

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SECTION 055000 - METAL FABRICATIONS

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. Steel framing and supports for mechanical ductwork, mechanical equipment and electrical equipment.
 - 2. Steel framing and supports for applications where framing and supports are not specified in other Sections.
- B. Products furnished, but not installed, under this Section:
 - 1. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.
- C. Related Sections:
 - 1. Section 099123 "Interior Painting"

1.3 ACTION SUBMITTALS

- A. Shop Drawings: Show fabrication and installation details for metal fabrications.
 - 1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.6 PROJECT CONDITIONS

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

1.7 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.2 FERROUS METALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Steel Tubing: ASTM A 500, cold-formed steel tubing.
- C. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40) unless otherwise indicated.

2.3 SLOTTED CHANNEL FRAMING (UNISTRUT OR EQUAL)

- A. Cold-formed metal box channels (struts) complying with MFMA-4.
 - 1. Size of Channels: 1-5/8 by 1-5/8 inches.
 - 2. Material: Cold-rolled steel, ASTM A 1008/A 1008M, 14 gage 0.0677-inch minimum thickness; coated with rust-inhibitive, baked-on, acrylic enamel.
 - 3. Provide all fittings, threaded rods, nuts, clamps and brackets as required for a complete assembly.

2.4 FASTENERS

- A. General: Unless otherwise indicated, provide Type 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.
- C. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 325, Type 3; with hex nuts, ASTM A 563, Grade C3; and, where indicated, flat washers.
- D. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, ASTM F 593; with hex nuts, ASTM F 594; and, where indicated, flat washers
- E. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.
 - 1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
- F. Eyebolts: ASTM A 489.
- G. Machine Screws: ASME B18.6.3.
- H. Lag Screws: ASME B18.2.1.
- I. Wood Screws: Flat head, ASME B18.6.1.
- J. Plain Washers: Round, ASME B18.22.1.
- K. Lock Washers: Helical, spring type, ASME B18.21.1.
- L. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.
- M. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.
 - 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.
 - 2. Material for Exterior Locations and Where Stainless Steel is Indicated: stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

2.5 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Shop Primers: Provide primers that comply with Section 099123 "Interior Painting".
- C. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
 - 1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- D. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
- E. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
- G. Nonshrink, Metallic Grout: Factory-packaged, ferrous-aggregate grout complying with ASTM C 1107, specifically recommended by manufacturer for heavy-duty loading applications.
- H. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- I. Concrete: normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 3000 psi.

2.6 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.

4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

2.7 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
 1. Fabricate units from slotted channel framing where indicated.
 2. Furnish inserts for units installed after concrete is placed.
- C. Galvanize miscellaneous framing and supports where indicated.
- D. Hot dip galvanize all steel which is exposed to the exterior.
- E. Prime miscellaneous framing and supports with zinc-rich primer where indicated.
- F. Exterior duct and pipe support is to remain hot dip galvanized without finish paint.

2.8 MISCELLANEOUS STEEL TRIM

- A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
- B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
- C. Galvanize exterior miscellaneous steel trim.
- D. Prime exterior miscellaneous steel trim with zinc-rich primer.

2.9 LOOSE BEARING AND LEVELING PLATES

- A. Provide loose bearing and leveling plates for steel items bearing on concrete construction. Drill plates to receive anchor bolts and for grouting.
- B. Galvanize plates.
- C. Prime plates with zinc-rich primer.

2.10 STEEL WELD PLATES AND ANGLES

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

2.11 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish metal fabrications after assembly.
- C. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.12 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
- B. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
 1. Shop prime with universal shop primer unless zinc-rich primer is otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- C. Field Welding: Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.
- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

3.3 INSTALLING BEARING AND LEVELING PLATES

- A. Clean concrete bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.
- B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.
 - 1. Use nonshrink grout, either metallic or nonmetallic, in concealed locations where not exposed to moisture; use nonshrink, nonmetallic grout in exposed locations unless otherwise indicated.
 - 2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.4 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - 1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099123 "Interior Painting".
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 055000

SECTION 061053 - MISCELLANEOUS ROUGH CARPENTRY

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. Fire retardant treated wood blocking, nailers or furring.
 - 2. Fire retardant plywood backing panels.
 - 3. Countertop support brackets.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
 - 1. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
 - 2. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
 - 3. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

1.4 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For the following, from ICC-ES:
 - 1. Fire-retardant-treated wood.
 - 2. Power-driven fasteners.
 - 3. Post-installed anchors.
 - 4. Metal framing anchors.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 FIRE-RETARDANT-TREATED MATERIALS

- A. General: **Only fire-retardant-treated materials are to be used on this project.** Materials shall comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
 - 1. Treatment shall not promote corrosion of metal fasteners.
 - 2. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.
- C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Kiln-dry plywood after treatment to a maximum moisture content of 15 percent.
- D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.

2.2 DIMENSION LUMBER FRAMING

- A. Other Framing: No. 2 Construction or No. 2 grade of any of the following species:
 - 1. Southern pine; SPIB.
 - 2. Douglas fir-larch; WCLIB or WWPA.

2.3 MISCELLANEOUS LUMBER

- A. General: Provide fire retardant treated miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
 - 1. Blocking.
 - 2. Nailers.
 - 3. Furring.
- B. Concealed Boards: 19 percent maximum moisture content of any of the following species and grades:
 - 1. Mixed southern pine or southern pine, No. 2 grade; SPIB.
 - 2. Hem-fir or hem-fir (north), Construction or No. 2 Common grade; NLGA, WCLIB, or WWPA.
 - 3. Spruce-pine-fir (south) or spruce-pine-fir, Construction or No. 2 Common grade; NeLMA, NLGA, WCLIB, or WWPA.
- C. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
- D. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.
- E. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.4 FIRE-RETARDANT-TREATED PLYWOOD

- A. General: Only fire-retardant-treated materials are to be used on this project. Materials shall comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
- B. Fire-Retardant-Treated Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
 - 1. Use treatment that does not promote corrosion of metal fasteners.
 - 2. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201/D 3201M at 92 percent relative humidity. Use where exterior type is not indicated.
 - 3. Design Value Adjustment Factors: Treated lumber plywood shall be tested according to ASTM D 5516 and design value adjustment factors shall be calculated according to ASTM D 6305. Span ratings after treatment shall be not less than span ratings specified.
- C. Kiln-dry material after treatment to a maximum moisture content of 15 percent. Do not use material that is warped or does not comply with requirements for untreated material.
- D. Identify fire-retardant-treated plywood with appropriate classification marking of qualified testing agency.
- E. Application: Treat all plywood unless otherwise indicated.
 - 1. Subflooring and underlayment for raised platforms.

2.5 PLYWOOD BACKING PANELS

- A. Equipment Backing Panels: Plywood, DOC PS 1, Exterior, A-C, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch nominal thickness.
 - 1. Plywood shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

- A. Counter Brackets: Basis of Design: Provide premanufactured 'L' shaped supports for countertops as manufactured by:
 - 1. Ragine Corporation: Rakks Specialty brackets www.rakks.com
 - a. Flush mounted Installation: installed prior to installation of gypsum board;
 - 2. EH series model Size as indicated or recommended for counter depth.
- B. Concealed floating shelf brackets: Basis of design: provide premanufactured heavy duty floating shelf bracket as manufactured by:
 - 1. Right On Bracket www.rightonbracket.com
 - a. Mounts behind drywall to side of studs. (provide FR Treated wood blocking to strengthen metal studs).
 - b. Thickness: 3/8" x length required by condition indicated on drawings.

2.7 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
- B. Screws for Fastening to Metal Framing: ASTM C 954, length as recommended by screw manufacturer for material being fastened.
- C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- D. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 as appropriate for the substrate.
 - 1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
 - 2. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2.

2.8 MISCELLANEOUS MATERIALS

- A. Adhesives for Gluing Furring to Concrete: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.
 - 1. Adhesives shall have a VOC content of 70 g/L or less.
 - 2. Adhesives shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- B. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry accurately to other construction. Locate furring, nailers, blocking and similar supports to comply with requirements for attaching other construction.
- C. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.
- D. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
- E. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- F. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. "Fastening Schedule," in ICC's International Building Code.
 - 2. ICC-ES evaluation report for fastener.

3.2 WOOD BLOCKING AND NAILER INSTALLATION

- A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
 - 1. Application: Provide blocking at the following wall locations as a minimum:
 - a. Cabinets.
 - b. Countertop support wall brackets.
 - c. TV Monitor Supports.
 - d. Wall-mounted door stops.
 - e. Signage - whether within this contract or provided by owner
 - f. Display Rails, marker boards, and other visual display items.
 - 2. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.
- B. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.3 WOOD FURRING INSTALLATION

- A. Use only fire retardant treated wood. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.
- B. Furring to Receive Plywood or Hardboard Paneling: Install 1-by-2-inch minimum nominal-size furring at o.c.

- C. Provide fire blocking in wood furred spaces as follows:
 - 1. Fire block furred spaces of walls at ceiling, and at not more than 96 inches o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.

END OF SECTION 061053

SECTION 06 4116 - PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Plastic-laminate-clad architectural cabinets.
 - 2. Plastic-laminate-clad countertops.
 - 3. Solid surface countertops.
 - 4. Cabinet hardware and accessories.
 - 5. Wood furring, blocking, shims, and hanging strips for installing plastic-laminate-clad architectural cabinets that are not concealed within other construction.
 - 6. Chair Rail

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. To indicate material seams, if needed.
- C. Samples: For each exposed product and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer and Installer.
- B. Product Certificates: Buy America Compliance Worksheet, as required by Project Contract Documents.

1.4 CLOSEOUT SUBMITTALS

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

1.5 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

- A. Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of cabinets indicated for construction, finishes, installation, and other requirements.
 - 1. Provide certificates from AWI certification program indicating that woodwork complies with requirements of grades specified.
- B. Architectural Woodwork Standards Grade: Premium.
- C. Type of Construction: Frameless.
- D. Door and Drawer-Front Style: Flush overlay.
 - 1. Reveal Dimension: As indicated on the Drawings.
- E. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or if not indicated, as required by quality standard.
 - 1. Manufacturers:
 - a. Formica
 - b. Wilsonart
 - c. Arborite
 - d. Or approved equal.
 - 1) Approved equals MUST be approved during bidding and be listed as approved in an addendum. It is the responsibility of the requestor to provide ample enough information (such as CSI Form 13.1A) to prove equality of requested "equal". If insufficient data is provided, substitution / approved equal request will be rejected.
 - 2. Basis of Design: As indicated on the Drawings.
- F. Laminate Cladding for Exposed Surfaces:
 - 1. Horizontal Surfaces: Grade HGS.
 - 2. Postformed Surfaces: Grade HGP.
 - 3. Vertical Surfaces: Grade VGS.
 - 4. Edges: Grade HGS.
 - 5. Pattern Direction: Vertically for drawer fronts, doors, and fixed panels.

- G. Exposed interior surfaces:
 - 1. Same as exterior.
- H. Semi-exposed surfaces:
 - 1. Melamine, color as selected by Architect from manufacturer's standard range.
- I. Concealed Backs of Panels with Exposed Plastic-Laminate Surfaces: High-pressure decorative laminate, NEMA LD 3, Grade BKL.
- J. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.
 - 1. Join subfronts, backs, and sides with glued dovetail joints.
- K. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
 - 1. As indicated in the drawings.

2.2 PLASTIC-LAMINATE-CLAD COUNTERTOPS

- A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of plastic-laminate-clad countertops indicated for construction, finishes, installation, and other requirements.
- B. Grade: Premium
- C. High-Pressure Decorative Laminate: NEMA LD 3, Grade HGS
 - 1. Manufacturers:
 - a. Wilsonart
 - b. Formica
 - c. Arborite
 - d. Or approved equal.
 - 1) Approved equals MUST be approved during bidding and be listed as approved in an addendum. It is the responsibility of the requestor to provide ample enough information (such as CSI Form 13.1A) to prove equality of requested "equal". If insufficient data is provided, substitution / approved equal request will be rejected.
- 2. Basis of Design: As indicated on the Drawings.
- D. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
 - 1. As indicated in the drawings.
- E. Edge Treatment: Same as laminate cladding on horizontal surfaces.
- F. Core Material: As selected by fabricator to comply with quality standard.
- G. Core Material at Sinks: Particleboard made with exterior glue.
- H. Core Thickness: 3/4 inch (19 mm).
 - 1. Build up countertop thickness to 1-1/2 inches (38 mm) at front, back, and ends with additional layers of core material laminated to top.
- I. Backer Sheet: Provide plastic-laminate backer sheet, NEMA LD 3, Grade BKL, on underside of countertop substrate.
- J. Paper Backing: Provide paper backing on underside of countertop substrate.

2.3 SOLID SURFACE COUNTERTOPS

- A. Solid Surface Material: Homogeneous-filled plastic resin complying with ICPA SS-1.
 - 1. Manufacturers:
 - a. Wilsonart
 - b. Formica
 - c. Corian
 - d. Or approved equal.
 - 1) Approved equals MUST be approved during bidding and be listed as approved in an addendum. It is the responsibility of the requestor to provide ample enough information (such as CSI Form 13.1A) to prove equality of requested "equal". If insufficient data is provided, substitution / approved equal request will be rejected.
 - 2. Basis of Design: As indicated on the Drawings.
 - a. Colors and Patterns: As indicated on the Drawings.
 - 3. Type: Provide Standard type unless Special Purpose type is indicated.
- B. Plywood: Exterior softwood plywood complying with DOC PS 1, Grade C-C Plugged, touch sanded.

2.4 SOLID SURFACE COUNTERTOP FABRICATION

- A. Fabricate countertops according to quartz agglomerate manufacturer's written instructions and the AWI/AWMAC/WI's "Architectural Woodwork Standards."
 - 1. Grade: Premium.
- B. Configuration:

1. Front: Straight, slightly eased at top
2. Backsplash: Straight, slightly eased at corner
3. End Splash: Matching backsplash
- C. Countertops: As indicated on the Drawings.
- D. Backsplashes: Same as countertop thickness.
- E. Joints: Fabricate countertops in sections for joining in field, with joints at locations indicated.
 1. Architect to approval seams prior to installation.
- F. Cutouts and Holes:
 1. Drop-In Plumbing Fixtures: Make cutouts for fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.

2.5 MATERIALS

- A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.
 1. Wood Moisture Content: 5 to 10 percent.
- B. Composite Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.
 1. MDF: ANSI A208.2, Grade 130.
 2. Particleboard (Medium Density): ANSI A208.1, Grade M-2
 3. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1.
 4. Thermoset Decorative Panels: Particleboard or MDF finished with thermally fused, melamine-impregnated decorative paper and complying with requirements of NEMA LD 3, Grade VGL, for Test Methods 3.3, 3.4, 3.6, 3.8, and 3.10.

2.6 CABINET HARDWARE AND ACCESSORIES

- A. Frameless Concealed Hinges (European Type): ANSI/BHMA A156.9, B01602, 135 degrees of opening.
 1. Operation: Soft-close.
 2. Finish: Brushed Satin Nickel
- B. Tab Pulls: Back mounted, solid metal, 4 ½ inch long,
 1. Finish: Brushed Satin Nickel / Stainless Steel
 2. Basis of Design: Top Knobs Europa Tab Pull
 3. Location:
 - a. Drawer: Horizontal, centered on top of drawer front
 - b. Door: Horizontal, at top interior corner of door.
- C. Catches: Ball friction catches, ANSI/BHMA A156.9, B03013.
- D. Shelf Rests: ANSI/BHMA A156.9, B04013; metal.
- E. Drawer Slides: ANSI/BHMA A156.9.
 1. Grade 1HD-100 and Grade 1HD-200: Side mounted; full extension type; zinc-plated-steel ball-bearing slides.
 2. Operation: Soft-close.
- F. Door and Drawer Silencers: ANSI/BHMA A156.16, L03011.
- G. Grommets for Cable Passage: 2-inch (51-mm) OD, molded-plastic grommets, and matching plastic caps with slot for wire passage.
 1. Color: To Match Color of Countertop
- H. General:
 1. Exposed Hardware Finishes: For exposed hardware, provide brushed nickel/stainless finish, unless noted otherwise.
 2. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in ANSI/BHMA A156.9.
- I. Trash Cans
 1. Contractor to provide standard trash can receptacles – one per trash drawer – in locations indicated in the Drawings.
 - a. Size: as required to fit in drawer

2.7 MISCELLANEOUS MATERIALS

- A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber
- B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.
- C. Adhesive for Bonding Plastic Laminate: Unpigmented contact cement.
 1. Adhesive for Bonding Edges: Hot-melt adhesive or adhesive specified above for faces.

2.8 FABRICATION

- A. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
- B. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
- C. Fabricate countertops to dimensions, profiles, and details indicated. Provide front and end overhang of 1 inch (25 mm) over base cabinets.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Before installation, condition cabinets to humidity conditions in installation areas for not less than 72 hours.
- B. Architectural Woodwork Standards Grade: Install cabinets to comply with quality standard grade of item to be installed.
- C. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with wafer-head cabinet installation screws.
- D. Countertop Installation: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.
 - 1. Install countertops level and true in line. Use concealed shims as required to maintain not more than a 1/8-inch-in-96-inches (3-mm-in-2400-mm) variation from a straight, level plane.
 - 2. Secure backsplashes to walls with adhesive.
 - 3. Seal joints between countertop and backsplash, if any, and joints where countertop and backsplash abut walls with mildew-resistant silicone sealant or another permanently elastic sealing compound recommended by countertop material manufacturer.
- E. Install cabinets level, plumb, and true in line to a tolerance of 1/8 inch in 96 inches (3 mm in 2400 mm) using concealed shims.
 - 1. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
 - 2. Install cabinets without distortion so doors and drawers fit openings and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
 - 3. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches (400 mm) o.c. with No. 10 wafer-head screws sized for not less than 1-1/2-inch (38-mm) penetration into wood framing, blocking, or hanging strips.
- F. Adhesive: Product recommended by material manufacturer.

3.2 FIELD QUALITY CONTROL

- A. Inspections: Provide inspection of installed Work certifying that woodwork, including installation, complies with requirements of the Architectural Woodwork Standards for the specified grade.

END OF SECTION 06 4116

SECTION 070150 - ROOFING PATCH AND REPAIR

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Partial tear-off of roof areas including removal of flashings and counterflashings impacted by mechanical work on the roof.
 - 2. Temporary roofing.
 - 3. Re-cover preparation of roof areas impacted by mechanical work.
 - 4. Reroofing with original manufacturer's materials to maintain warranties.
- B. Related Requirements:
 - 1. Section 011000 "Summary" for use of premises and for phasing requirements.
 - 2. Section 015000 "Temporary Facilities and Controls" for temporary construction and environmental-protection measures for reroofing preparation.

1.2 PREINSTALLATION MEETINGS

- A. Preliminary Roofing Conference: Before starting removal Work, conduct conference at Project site.
 - 1. Meet with Owner, Architect, Owner's representative, roofing Installer, mechanical contractors responsible for mounting roof-mounted equipment.
 - 2. Review methods and procedures related to roofing tear-off, including, but not limited to, the following:
 - a. Temporary protection requirements for existing roofing system components that are to remain.
 - b. Base flashings, special roofing details, drainage, penetrations, equipment curbs, and condition of other construction that affect reroofing.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
 - 1. Include certificate that Installer is approved by warrantor of existing roofing system.
- B. Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including exterior and interior finish surfaces, that might be misconstrued as having been damaged by reroofing operations. Submit before Work begins.

1.5 CLOSEOUT SUBMITTALS

- A. Certified statement from Roofing Systems manufacturer stating that existing roof warranty has not been affected by Work performed under this Section.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Approved by warrantor of existing roofing system to work on existing roofing.

1.7 FIELD CONDITIONS

- A. Existing Roofing System: BUR-modified bituminous protected membrane roofing.
- B. Owner will occupy portions of building immediately below reroofing area.
 - 1. Conduct reroofing so Owner's operations are not disrupted.
 - 2. Provide Owner with not less than 72 hours' written notice of activities that may affect Owner's operations.
 - 3. Coordinate work activities daily with Owner so Owner has adequate advance notice to place protective dust and water-leakage covers over sensitive equipment and furnishings.
 - 4. Coordinate with Owner to shut down air intake HVAC equipment in the area of work and fire-alarm or -detection equipment if needed.
- C. Protect building to be reroofed, adjacent buildings, walkways, site improvements, exterior plantings, and landscaping from damage or soiling from reroofing operations.
- D. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities.
- E. Conditions existing at time of inspection for bidding will be maintained by Owner as far as practical.
- F. Weather Limitations: Proceed with reroofing preparation only when existing and forecasted weather conditions permit Work to proceed without water entering existing roofing system or building.
 - 1. Remove only as much roofing in one day as can be made watertight in the same day.
- G. Hazardous Materials: It is not expected that hazardous materials, such as asbestos-containing materials, will be encountered in the Work.
 - 1. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner.

2. Coordinate removal of hazardous materials with Owner.

1.8 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during reroofing, by methods and with materials so as not to void existing roofing system warranty. Verify existing warranty with owner.
 1. Notify warrantor before proceeding with the Work.
 2. Notify warrantor of existing roofing system on completion of reroofing, and obtain documentation verifying that existing roofing system has been inspected and warranty remains in effect.
 - a. Submit documentation at Project closeout.

PART 2 - PRODUCTS

2.1 INFILL AND REPLACEMENT MATERIALS

- A. Use infill materials matching existing roofing system materials unless otherwise indicated.
 1. Description of existing roofing system below are provided for Contractor's convenience and information, but they are not a warranty of existing conditions. They are intended to supplement rather than serve in lieu of Contractor's own investigations.

2.2 MANUFACTURERS

- A. Basis-of-Design Products: Subject to compliance with requirements, provide Asphalt BUR Modified Bitumen Roof assembly components to match configuration of existing roof.
- B. Top Coat: GAF TOPCOAT water based elastomeric coating.

2.3 PERFORMANCE REQUIREMENTS

- A. Material Compatibility: Roofing materials to be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roof membrane manufacturer based on testing and field experience.

2.4 AUXILIARY ROOFING MATERIALS

- A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with built-up roofing.
- B. Roofing Asphalt: ASTM D 312, Type III or IV
- C. Asphalt Primer: ASTM D 41. Basis of Design: Asphalt Primer
- D. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required by roofing system manufacturer for application. Basis of Design: Bestile Industrial Roof Cement
- E. Cold-Applied Flashing Adhesive: Roofing system manufacturer's asphalt-based, two-component, asbestos-free, trowel-grade, cold-applied adhesive specially formulated for compatibility and use with flashing applications. Basis of Design: MBR Flashing Cement
- F. Mastic Sealant: Polyisobutylene, plain or modified bitumen; nonhardening, nonmigrating, nonskinning, and nondrying.
- G. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening roofing membrane components to substrate, tested by manufacturer for required pullout strength, and provided by the roofing system manufacturer. Basis of Design: UltraFast Fasteners and Plates
- H. Roofing Granules: Ceramic-coated roofing granules matching existing cap sheet, provided by roofing system manufacturer.
- I. Coating: Acrylic elastomeric coating with unique bleed-blocking properties particularly well suited for coating over asphalt surfaces. Basis of Design: JM CR Seam Coating
- J. Miscellaneous Accessories: Provide miscellaneous accessories recommended by roofing system manufacturer.

2.5 ROOF INSULATION

- A. General: Preformed roof insulation boards that comply with requirements and referenced standards, selected from manufacturer's standard sizes and of thicknesses indicated.
- B. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Basis of Design: ENRGY 3
 1. Provide insulation to match existing thickness and taper.

2.6 TAPERED INSULATION

- A. Tapered Insulation: ASTM C 1289, provide factory-tapered insulation boards fabricated to match existing slope or 1/4 inch per 12 inches (1:48) if not adjacent to existing sloped area. Basis of Design: Tapered ENRGY 3.
- B. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

2.7 INSULATION ACCESSORIES

- A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with roofing.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer.
- C. Cold Fluid-Applied Adhesive: Manufacturer's No VOC, two-component cold fluid-applied adhesive formulated to adhere roof insulation to substrate. Basis of Design: MBR Bonding Adhesive or architect pre approved equal.
- D. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:
 - 1. Modified asphaltic, asbestos-free, cold-applied adhesive.
 - 2. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
- E. Insulation Cant Strips: ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board.
- F. Wood Nailer Strips: Comply with requirements in Section 061053 "Miscellaneous Rough Carpentry."

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Protect existing roofing system that is not to be reroofed.
 - 2. Loosely lay 1-inch- (25-mm-) minimum thick, EPS insulation over existing roofing in areas not to be reroofed.
 - a. Loosely lay 15/32-inch (12-mm) plywood or OSB panels over EPS. Extend EPS past edges of plywood or OSB panels a minimum of 1 inch (25 mm).
 - 3. Limit traffic and material storage to areas of existing roofing that have been protected.
 - 4. Maintain temporary protection and leave in place until replacement roofing has been completed. Remove temporary protection on completion of reroofing.
 - 5. Comply with requirements of existing roof system manufacturer's warranty requirements.
- B. Shut off rooftop utilities and service piping before beginning the Work.
- C. Test existing roof drains to verify that they are not blocked or restricted.
 - 1. Immediately notify Architect of any blockages or restrictions.
- D. Coordinate with General Contractor and Owner to shut down air-intake equipment in the vicinity of the Work.
 - 1. Cover air-intake louvers before proceeding with reroofing work that could affect indoor air quality or activate smoke detectors in the ductwork.
- E. During removal operations, have sufficient and suitable materials on-site to facilitate rapid installation of temporary protection in the event of unexpected rain.
- F. Maintain roof drains in functioning condition to ensure roof drainage at end of each workday.
 - 1. Prevent debris from entering or blocking roof drains and conductors.
 - a. Use roof-drain plugs specifically designed for this purpose.
 - b. Remove roof-drain plugs at end of each workday, when no work is taking place, or when rain is forecast.
 - 2. If roof drains are temporarily blocked or unserviceable due to roofing system removal or partial installation of new roofing system, provide alternative drainage method to remove water and eliminate ponding.
 - a. Do not permit water to enter into or under existing roofing system components that are to remain.

3.2 INSTALLATION OF ROOFING, GENERAL

- A. Install roofing system in accordance with manufacturer's written instructions, and all applicable roof assembly requirements.
- B. Complete terminations and base flashings, and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast.
- C. Remove and discard temporary seals before beginning work on adjoining roofing.

- D. Install roof membrane and auxiliary materials to tie into existing roofing to maintain weathertightness of transitions.

3.3 INFILL MATERIALS INSTALLATION

- A. Immediately after roof tear-off, and inspection and repair, if needed, of deck, fill in tear-off areas to match existing roofing system construction.
- B. Install new roofing patch over roof infill area.
 - 1. If new roofing is installed the same day tear-off is made, roofing patch is not required.
- C. All infill materials should be installed in accordance with manufacturer's recommendations.

3.4 TEMPORARY ROOFING

- A. Install approved temporary roofing over area to be reroofed.
- B. Install temporary roofing over area to be reroofed.
- C. Remove temporary roofing before installing new roofing.

3.5 DISPOSAL

- A. Collect demolished materials and place in containers.
 - 1. Promptly dispose of demolished materials.
 - 2. Do not allow demolished materials to accumulate on-site.
 - 3. Storage or sale of demolished items or materials on-site is not permitted.
- B. Transport and legally dispose of demolished materials off Owner's property.

END OF SECTION 070150

SECTION 072100 - INSULATION

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: (insulation primary use/location)
 - 1. Glass-fiber blanket insulation: stud cavities at interior walls as indicated for acoustical purpose.
 - 2. Loose-fill insulation: as needed.
 - 3. Prefinished continuous insulation for interior use.
- B. Related Sections:
 - 1. Section 092216 "Non Structural Metal Framing"
 - 2. Section 092900 "Gypsum Board"

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.
- B. Research/Evaluation Reports: For foam-plastic insulation, from ICC-ES.

1.5 QUALITY ASSURANCE

- 1. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

PART 2 - PRODUCTS

2.1 MINERAL-WOOL BLANKET INSULATION

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Roxul Inc.
 - 2. Thermafiber.
- B. Unfaced, Mineral-Wool Blanket Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.
- C. For use in hollow metal frames as sound deadening.

2.2 GLASS-FIBER BLANKET INSULATION

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. CertainTeed Corporation.
 - 2. Guardian Building Products, Inc.
 - 3. Johns Manville.
 - 4. Knauf Insulation.
 - 5. Owens Corning.
- B. Unfaced, Glass-Fiber Blanket Insulation: ASTM C 665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics. For use as sound attenuation blankets for interior walls.
- C. Where glass-fiber blanket insulation is indicated by the following thicknesses, provide blankets in batt or roll form with thermal resistances indicated:
 - 1. 3-1/2 inches thick with a minimum thermal resistance of 11 deg F x h x sq. ft. /Btu at 75 deg F.
 - 2. 5-1/2 inches thick with a minimum thermal resistance of 19 deg F x h x sq. ft. /Btu at 75 deg F.

2.3 LOOSE-FILL INSULATION

- A. Glass-Fiber Loose-Fill Insulation: ASTM C 764, Type I for pneumatic application or Type II for poured application; with maximum flame-spread and smoke-developed indexes of 5, per ASTM E 84.

2.4 CONTINUOUS INSULATION BOARD FOR INTERIOR USE

- A. Closed cell polyisocyanurate foam core board insulation with glass fiber reinforce aluminum facers on both sides for use at roof top penthouse mechanical room.
- B. Exposed side to have white modified acrylic coating
- C. Product: Sika Rmax TSX 8510
 - 1. Product information: (all information listed based on Sika TSX 8510 manufacturer's data).
 - 2. Class A flame spread and smoke developed per IBC chapter 8 interior finishes.
 - 3. International Building Code (IBC) Section 2603, Foam Plastic
 - a. Tested per UL1715/NFPA 286 to comply with IBC Section 2603, Special Approval paragraph 2603.9
 - 1) Up to 4.5" without a thermal barrier on walls only
 - 2) Up to 12" without a thermal or ignition barrier on ceilings only
 - 3) Up to 4.5" without an ignition barrier on walls and ceilings
- D. Provide thickness of panel as indicated or equivalent in R value to that shown on drawings.

2.5 INSULATION FASTENERS

- A. Glass Fiber Blanket Insulation Wire Batt Supports Product with ability to attach glass fiber insulation to studs at walls thus preventing sag of insulation into cavity.
 - 1. For installation of batt or blanket insulation providing wire tie attachment to studs utilizing galvanized metal.
 - 2. Products: J&R Products, Inc. Wire Batt supports or equal

2.6 ACCESSORIES

- 1. Spray Polyurethane Foam Insulation: ASTM C 1029, Type II, closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean substrates of substances that are harmful to insulation or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- C. Extend insulation 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. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.3 INSTALLATION OF INSULATION FOR FRAMED CONSTRUCTION

- A. Glass-Fiber Blanket Insulation: Install in cavities formed by framing members according to the following requirements:
 - 1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
 - 2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
 - 3. Support unfaced blankets mechanically with wire batt supports between metal studs.
- B. Loose-Fill Insulation: Apply according to ASTM C 1015 and manufacturer's written instructions. Level horizontal applications to uniform thickness as indicated, lightly settle to uniform density, but do not compact excessively.
- C. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
 - 1. Loose-Fill Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft.
- D. Continuous Insulation Board at roof top penthouse mechanical room: Install prefinished board product per manufacturer's instructions.

1. Butt panels together and secure to framing as indicated by manufacturer.
2. Utilize manufacturer's PVC insulation clips.
3. Attach Quick Clip to wall through pre-punched holes at 12 inches o.c. Attach Quick Clip to wall or ceiling through pre-punched holes at 12 inches o.c.
 - a. Apply sealant along length of both sides of quick clip prior to sliding insulation board into place.
 - b. Use a J-channel at corners.

END OF SECTION 072100

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SECTION 078413 - PENETRATION FIRESTOPPING

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. Penetrations in fire-resistance-rated walls.
 - 2. Penetrations in horizontal assemblies.
- B. Related Sections:
 - 1. Reference Mechanical Electrical and Plumbing Drawings and specifications for specific notes and details related to anticipated MEP firestopping.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Product Schedule: For each penetration firestopping system. Include location and design designation of qualified testing and inspecting agency.
 - 1. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Installer Certificates: From Installer indicating penetration firestopping has been installed in compliance with requirements and manufacturer's written recommendations.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for penetration firestopping.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Must be a single installer and a firm experienced in installing penetration fire stopping similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance.
- B. Installer shall be certified, licensed, FM approved in accordance with PM 4991, certified by UL as a qualified contractor.
- C. Fire-Test-Response Characteristics: Penetration fire stopping shall comply with the following requirements:
 - 1. Penetration fire stopping tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
 - 2. Penetration fire stopping is identical to those tested per testing standard referenced in "Penetration Fire stopping" Article.
- D. Provide rated systems complying with the following requirements:
 - 1. Penetration fire stopping products bear classification marking of a qualified testing and inspecting agency.
 - 2. Classification markings on penetration fire stopping correspond to designations listed by the following:
 - a. UL in its "Fire Resistance Directory."
 - 3. Obtain fire stop systems for each type of penetration or joint opening and construction condition Indicated from a single manufacturer. Fire Stopping Contractor shall submit certificates and qualifications for approval prior to commencement of work.
- E. Preinstallation Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install penetration firestopping when ambient or substrate temperatures are outside limits permitted by penetration firestopping manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.
- B. Install and cure penetration firestopping per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.7 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping.
- C. Notify Owner's testing agency at least seven days in advance of penetration firestopping installations; confirm dates and times on day preceding each series of installations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. A/D Fire Protection Systems Inc.
 - 2. Grace Construction Products.
 - 3. Hilti, Inc.
 - 4. Johns Manville.
 - 5. Nelson Firestop Products.
 - 6. NUCO Inc.
 - 7. Passive Fire Protection Partners.
 - 8. RectorSeal Corporation.
 - 9. Specified Technologies Inc.
 - 10. 3M Fire Protection Products.
 - 11. Tremco, Inc.; Tremco Fire Protection Systems Group.
 - 12. USG Corporation.

2.2 PENETRATION FIRESTOPPING

- A. Provide penetration firestopping that is 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. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.
- B. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
 - 1. Fire-resistance-rated walls include fire-barrier walls, smoke-barrier walls, and fire partitions.
 - 2. F-Rating: Not less than the fire-resistance rating of constructions penetrated.
- C. Penetrations in Horizontal Assemblies: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
 - 1. Horizontal assemblies include floors, roofs, and ceiling membranes of rated ceiling assemblies.
 - 2. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.
 - 3. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
- D. Penetrations in Smoke Barriers: Provide penetration firestopping with ratings determined per UL 1479.
 - 1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at 0.30-inch wg at both ambient and elevated temperatures.
- E. W-Rating: Provide penetration firestopping showing no evidence of water leakage when tested according to UL 1479.
- F. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- G. VOC Content: Penetration firestopping sealants and sealant primers shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - 1. Sealants: 250 g/L.
 - 2. Sealant Primers for Nonporous Substrates: 250 g/L.
 - 3. Sealant Primers for Porous Substrates: 775 g/L.
- H. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.
 - 1. Permanent forming/damming/backing materials, including the following:
 - a. Slag-wool-fiber or rock-wool-fiber insulation.
 - b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
 - c. Fire-rated form board.
 - d. Fillers for sealants.

2. Temporary forming materials.
3. Substrate primers.
4. Collars.
5. Steel sleeves.

2.3 FILL MATERIALS

- A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
- B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.
- C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel sheet.
- E. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.
- F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
- G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
- H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.
- I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
- J. 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, and nonsag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of nonsag grade for both opening conditions.

2.4 MIXING

- A. For those products requiring mixing before application, comply with penetration firestopping manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning: Clean out openings immediately before installing penetration firestopping to comply with manufacturer's written instructions and with the following requirements:
 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping.
 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping. Remove loose particles remaining from cleaning operation.
 3. Remove laitance and form-release agents from concrete.
- B. Priming: Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

- C. Masking Tape: Use masking tape to prevent penetration firestopping from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping's seal with substrates.

3.3 INSTALLATION

- A. General: Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
 - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestopping.
- C. Install fill materials for firestopping by proven techniques to produce the following results:
 - 1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
 - 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 - 3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

- A. Identify penetration firestopping with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of firestopping edge so labels will be visible to anyone seeking to remove penetrating items or firestopping. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
 - 1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
 - 2. Contractor's name, address, and phone number.
 - 3. Designation of applicable testing and inspecting agency.
 - 4. Date of installation.
 - 5. Manufacturer's name.
 - 6. Installer's name.

3.5 FIELD QUALITY CONTROL

- A. Owner will engage a qualified testing agency to perform tests and inspections.
- B. Where deficiencies are found or penetration firestopping is damaged or removed because of testing, repair or replace penetration firestopping to comply with requirements.
- C. Proceed with enclosing penetration firestopping with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

- A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping is without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping and install new materials to produce systems complying with specified requirements.

END OF SECTION 078413

SECTION 079200 - JOINT SEALANTS

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. Silicone joint sealants.
 - 2. Urethane joint sealants.
 - 3. Latex joint sealants.
 - 4. Acoustical joint sealants.
- B. Related Sections:
 - 1. Section 078413 "Penetration Firestopping" for sealing penetrations in fire-resistance-rated construction.
 - 2. Section 088000 "Glazing" for glazing sealants.
 - 3. Section 092900 "Gypsum Board" for sealing perimeter joints.
 - 4. Section 095113 "Acoustical Panel Ceilings" for sealing edge moldings at perimeters with acoustical sealant.

1.3 PRECONSTRUCTION TESTING

- A. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
 - 1. Use ASTM C 1087 manufacturer's standard test method to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
 - 2. Submit not fewer than eight pieces of each kind of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
 - 3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
 - 4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
 - 5. Testing will not be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.
- B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:
 - 1. Locate test joints at existing unknown surfaces (existing painted or prefinished materials).
 - 2. Conduct field tests for each application indicated below:
 - a. Each kind of sealant and joint substrate indicated at affected locations.
 - 3. Notify Owner and Architect seven days in advance of dates and times when test joints will be erected.
 - a. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
 - 1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
 - 4. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
 - 5. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.4 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- B. Joint-Sealant Schedule: Include the following information:
 - 1. Joint-sealant application, joint location, and designation.
 - 2. Joint-sealant manufacturer and product name.
 - 3. Joint-sealant formulation.
 - 4. Joint-sealant color.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer and testing agency.
- B. Product Certificates: For each kind of joint sealant and accessory, from manufacturer.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that sealants comply with requirements.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Source Limitations: Obtain each kind of joint sealant from single source from single manufacturer.
- C. Product Testing: Test joint sealants using a qualified testing agency.
 - 1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
 - 2. Test according to SWRI's Sealant Validation Program for compliance with requirements specified by reference to ASTM C 920 for adhesion and cohesion under cyclic movement, adhesion-in-peel, and indentation hardness.

1.7 PROJECT CONDITIONS

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

1.8 WARRANTY

- A. Special Installer's Warranty: Manufacturer's standard form in which Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Manufacturer's Warranty: Manufacturer's standard form in which joint-sealant manufacturer agrees to furnish joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: 10 years from date of Substantial Completion.
- C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
 - 1. Movement of the structure caused by structural settlement or errors attributable to design or construction resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
 - 2. Disintegration of joint substrates from natural causes exceeding design specifications.
 - 3. Mechanical damage caused by individuals, tools, or other outside agents.
 - 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
 - 1. Suitability for Immersion in Liquids: Where sealants are indicated for Use I for joints that will be continuously immersed in liquids, provide products that have undergone testing according to ASTM C 1247. Liquid used for testing sealants is deionized water, unless otherwise indicated.
- C. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
- D. Suitability for Contact with Food: Where sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.
- E. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 URETHANE SEALANTS: JS-#1

- A. Urethane, M, P, 50, T, NT: Multicomponent, pourable, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type M, Grade P, Class 50, Uses T and NT
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. LymTal International Inc. ISOFlex 888 QC sealant
 - b. Or approved equal.

2.3 URETHANE SEALANTS: JS-#2

- A. General information: Minimum Requirements are stated: Products capable of greater movement are also indicated and are acceptable but not required.
- B. Urethane, M, NS, 25, NT: Multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, urethane joint sealant; ASTM C 920, Type M, Grade NS, Class 25, Use NT.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Sherwin-Williams Company (The); Stampede-2NS.
 - b. Bostik, Inc.; Chem-Calk 505.
 - c. LymTal International, Inc.; Iso-Flex 881 Iso-Flex 885 SG.
 - d. Sika Corporation U.S.; Sikaflex - 2c NS EZ Mix.
 - e. Pecora Corporation; Dynatrol II.
 - f. Tremco Incorporated; Dymeric 240.
 - g. Or approved equal

2.4 SILICONE JOINT SEALANTS JS-#3

- A. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 50, for Use NT.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. BASF Building Systems; Omniseal 50.
 - b. Dow Corning Corporation; 791.
 - c. Pecora Corporation; 895.
 - d. Polymeric Systems, Inc.; PSI-641.
 - e. Sika Corporation, Construction Products Division; SikaSil-C995.
 - f. Tremco Incorporated; Spectrem 2.
 - g. Or approved equal.

2.5 SILICONE JOINT SEALANTS: JS-#4

- A. Mildew-Resistant, Single-Component, Nonsag, Neutral-Curing Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Pecora Corporation; 898.
 - b. Dow Corning Corporation; 786 Mildew Resistant
 - c. Tremco; Tremsil 600.
 - a. Or approved equal.

2.6 LATEX JOINT SEALANTS: JS-#5

- A. Latex Joint Sealant: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. BASF Building Systems; Sonolac.
 - b. Bostik, Inc.; Chem-Calk 600.
 - c. Pecora Corporation; AC-20+.
 - d. Tremco Incorporated; Tremflex 834.
 - e. Or approved equal.

2.7 ACOUSTICAL JOINT SEALANTS: JS#6

- A. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Pecora Corporation; AC-20 FTR.
 - b. USG Corporation; SHEETROCK Acoustical Sealant.
 - c. Or approved equal.

2.8 JOINT SEALANT BACKING

- A. General: Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin) Type O (open-cell material) Type B (bicellular material with a surface skin) or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.9 MISCELLANEOUS MATERIALS

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

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
 - a. Concrete.
 - b. Masonry.
 - c. Unglazed surfaces of ceramic tile.
 - d. Exterior insulation and finish systems.
 3. Remove laitance and form-release agents from concrete.
 4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
 - a. Metal.
 - b. Glass.
 - c. Porcelain enamel.
 - d. Glazed surfaces of ceramic tile.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of sealant backings.
 - 2. Do not stretch, twist, puncture, or tear sealant backings.
 - 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 - 1. Remove excess sealant from surfaces adjacent to joints.
 - 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 - 3. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.
 - 4. Provide flush joint profile where indicated per Figure 8B in ASTM C 1193.
 - 5. Provide recessed joint configuration of recess depth and at locations indicated per Figure 8C in ASTM C 1193.
 - a. Use masking tape to protect surfaces adjacent to recessed tooled joints.
- G. Installation of Preformed Silicone-Sealant System: Comply with the following requirements:
 - 1. Apply masking tape to each side of joint, outside of area to be covered by sealant system.
 - 2. Apply silicone sealant to each side of joint to produce a bead of size complying with preformed silicone-sealant system manufacturer's written instructions and covering a bonding area of not less than 3/8 inch. Hold edge of sealant bead 1/4 inch inside masking tape.
 - 3. Within 10 minutes of sealant application, press silicone extrusion into sealant to wet extrusion and substrate. Use a roller to apply consistent pressure and ensure uniform contact between sealant and both extrusion and substrate.
 - 4. Complete installation of sealant system in horizontal joints before installing in vertical joints. Lap vertical joints over horizontal joints. At ends of joints, cut silicone extrusion with a razor knife.
- H. Installation of Preformed Foam Sealants: Install each length of sealant immediately after removing protective wrapping. Do not pull or stretch material. Produce seal continuity at ends, turns, and intersections of joints. For applications at low ambient temperatures, apply heat to sealant in compliance with sealant manufacturer's written instructions.
- I. Acoustical Sealant Installation: At sound-rated assemblies and elsewhere as indicated, seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations.

3.4 FIELD QUALITY CONTROL

- A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
 - 1. Extent of Testing: Test completed and cured sealant joints as follows:
 - a. Perform 10 tests for the first 1000 feet of joint length for each kind of sealant and joint substrate.
 - b. Perform 1 test for each 1000 feet of joint length thereafter or 1 test per each floor per elevation.
 - 2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.

- a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
 3. Inspect tested joints and report on the following:
 - a. Whether sealants filled joint cavities and are free of voids.
 - b. Whether sealant dimensions and configurations comply with specified requirements.
 - c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.
 4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
 5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.
- B. Evaluation of Field-Adhesion Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.5 CLEANING

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

3.6 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.7 JOINT-SEALANT SCHEDULE

- A. **JS-#1** Joint-Sealant Application: interior joints in horizontal traffic surfaces
 1. Joint Locations:
 - a. Horizontal joints in surfaces of concrete, between metal and concrete, mortar, stone and masonry.
 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range.
- B. **JS-#2** Joint-Sealant Application: Exterior Sealant: Polyurethane; ASTM C 920, Grade NS, Class 25, Uses M,G, and A; single component
 1. Joint Locations:
 - a. Control, expansion, and soft joints in masonry.
 - b. Joints between concrete and other materials.
 - c. Joints between metal frames and other materials.
 - d. Other exterior joints for which no other sealant is indicated.
 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range.
- C. **JS-#3** Joint-Sealant Application:
 1. Joint Sealant Location:
 - a. Joints in masonry where silicone sealant was previously used.
 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range.
- D. **JS-#4** Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.
 1. Joint Sealant Location:
 - a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
 - b. Tile control and expansion joints where indicated.
 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- E. **JS-#5** Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces
 1. Joint Locations:
 - a. Control and expansion joints on exposed interior surfaces of exterior walls.
 - b. Perimeter joints of exterior openings where indicated.
 - c. Tile control and expansion joints.
 - d. Vertical joints on exposed surfaces of interior unit masonry concrete walls and partitions.
 - e. Perimeter joints between interior wall surfaces and frames of interior doors windows and elevator entrances.

- f. Interior wall and ceiling control joints.
 - g. Joints between door and window frames and wall surfaces.
 - h. Other interior joints for which no other type of sealant is indicated.
 - 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- F. **JS-#6.** Joint-Sealant Application: Interior acoustical joints in vertical surfaces and horizontal nontraffic surfaces
 - 1. Joint Location:
 - a. Acoustical joints where indicated.
 - 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range (where exposed to view).

END OF SECTION 079200

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SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Interior standard steel doors and frames.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Include the following:
 - 1. Elevations of each door type.
 - 2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
 - 3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
- C. Product Schedule: For hollow-metal doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

1.3 INFORMATIONAL SUBMITTALS

- A. Product test reports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ceco Door; ASSA ABLOY.
 - 2. Curries Company; ASSA ABLOY.
 - 3. Republic Doors and Frames.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings[and temperature-rise limits] indicated on Drawings, based on testing at positive pressure according to NFPA 252 or UL 10C.
 - 1. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.

2.3 INTERIOR STANDARD STEEL DOORS AND FRAMES

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

- a. Type: As indicated in the Door and Frame Schedule.
 - b. Thickness: 1-3/4 inches (44.5 mm).
 - c. Face: Uncoated steel sheet, minimum thickness of 0.059 inch (1.6 mm).
 - d. Edge Construction: Model 2, Fully welded seamless edge.
 - e. Core: Manufacturer's standard.
 - f. Fire-Rated Core: Manufacturer's standard vertical steel stiffener core for fire-rated doors.
2. Frames:
- a. Materials: Uncoated steel sheet, minimum thickness of 0.059 inch (1.6 mm).
 - b. Construction: Welded Face Seam, ground and dress smooth.
 - c. SDI Level 3, 16 gauge.

2.4 FRAME ANCHORS

- A. Jamb Anchors:
- 1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
 - 2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches (610 mm) of frame height above 7 feet (2.1 m).
 - 3. Postinstalled Expansion Anchor: Minimum 3/8-inch- (9.5-mm-) diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.
- B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.
- C. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z (12G) coating designation; mill phosphatized.
- 1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized according to ASTM A153/A153M, Class B.

2.5 MATERIALS

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- C. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- D. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.
- E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A153/A153M.
- F. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.
- G. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.

- H. Glazing: Comply with requirements in Section 088000 "Glazing."

2.6 FABRICATION

- A. Door Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch (19 mm) beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.
- B. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.
1. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 2. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
 - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
 - b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.
- C. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping according to ANSI/SDI A250.6, the Door Hardware Schedule, and templates.
1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
 2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.

2.7 STEEL FINISHES

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

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

- A. Hollow-Metal Frames: Comply with ANSI/SDI A250.11.
1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.
 - a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
 - b. Install frames with removable stops located on secure side of opening.

2. Fire-Rated Openings: Install frames according to NFPA 80.
3. Floor Anchors: Secure with postinstalled expansion anchors.
 - a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
4. Solidly pack mineral-fiber insulation inside frames.
5. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar.
6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
7. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
 - a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.
- B. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.
 1. Non-Fire-Rated Steel Doors: Comply with ANSI/SDI A250.8.
 2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
- C. Glazing: Comply with installation requirements in Section 088000 "Glazing" and with hollow-metal manufacturer's written instructions.

3.3 FIELD QUALITY CONTROL

- A. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
- B. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

3.4 REPAIR

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

END OF SECTION 081113

SECTION 081416 - FLUSH WOOD DOORS

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. Five-ply flush wood veneer-faced doors for transparent finish.
 - 2. Five-ply flush wood doors for opaque finish.
 - 3. Factory finishing flush wood doors.
 - 4. Factory fitting flush wood doors to frames and factory machining for hardware.
- B. Related Requirements:
 - 1. Section 064216 "Flush Wood Paneling" for requirements for veneers from the same flitches for both flush wood doors and flush wood paneling.
 - 2. Section 088000 "Glazing" for glass view panels in flush wood doors.
 - 3. Section 099123 "Interior Painting" and Section 099300 "Staining and Transparent Finishing" for field finishing doors.

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product, including the following:
 - 1. Door core materials and construction.
 - 2. Door edge construction
 - 3. Door face type and characteristics.
 - 4. Door louvers.
 - 5. Door trim for openings.
 - 6. Door frame construction.
 - 7. Factory-machining criteria.
 - 8. Factory-finishing specifications.
- B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each type of door; construction details not covered in Product Data; and the following:
 - 1. Door schedule indicating door location, type, size, fire protection rating, and swing.
 - 2. Door elevations, dimension and locations of hardware, lite and louver cutouts, and glazing thicknesses.
 - 3. Details of frame for each frame type, including dimensions and profile.
 - 4. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
 - 5. Dimensions and locations of blocking for hardware attachment.
 - 6. Dimensions and locations of mortises and holes for hardware.
 - 7. Clearances and undercuts.
 - 8. Requirements for veneer matching.
 - 9. Doors to be factory finished and application requirements.
 - 10. Apply AWI Quality Certification Program label to Shop Drawings.
- C. Samples for Initial Selection: For factory-finished doors.
- D. Samples for Verification:
 - 1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches for each material and finish. For each wood species and transparent finish, provide set of three Samples showing typical range of color and grain to be expected in finished Work.
 - 2. Polymer edging, in manufacturer's standard colors.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For door inspector.
 - 1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, Section 5.2.3.1.
 - 2. Egress Door Inspector: Submit documentation of compliance with NFPA 101, Section 7.2.1.15.4.
 - 3. Submit copy of DHI's Fire and Egress Door Assembly Inspector (FDAI) certificate.
- B. Field quality-control reports.

- C. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Special warranties.
- B. Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.
- C. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

1.7 QUALITY ASSURANCE

- A. Manufacturer's Certification: Licensed participant in AWI's Quality Certification Program.
- B. Fire-Rated Door Inspector Qualifications: Inspector for field quality-control inspections of fire-rated door assemblies shall comply with qualifications set forth in NFPA 80, Section 5.2.3.1 and the following:
 - 1. DHI's Fire and Egress Door Assembly Inspector (FDAI) certification.
- C. Egress Door Inspector Qualifications: Inspector for field quality-control inspections of egress door assemblies shall comply with qualifications set forth in NFPA 101, Section 7.2.1.15.4 and the following:
 - 1. DHI's Fire and Egress Door Assembly Inspector (FDAI) certification.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of referenced standard and manufacturer's written instructions.
- B. Package doors individually in cardboard cartons, and wrap bundles of doors in plastic sheeting.
- C. Mark each door on bottom rail with opening number used on Shop Drawings.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and HVAC system is operating and maintaining temperature and relative humidity at levels designed for building occupants for the remainder of construction period.
- B. Environmental Limitations: Do not deliver or install doors until building is enclosed and weathertight, wet work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between 25 and 55 percent during remainder of construction period.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Delamination of veneer.
 - b. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
 - c. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.
 - 2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
 - 3. Warranty Period for Solid-Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain flush wood doors indicated to be blueprint matched with paneling and wood paneling from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Wood Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated on Drawings, based on testing at positive pressure in accordance with UL 10C or NFPA 252.
 - 1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
- B. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing in accordance with UL 1784 and installed in compliance with NFPA 105.

2.3 FLUSH WOOD DOORS, GENERAL

- A. Quality Standard: In addition to requirements specified, comply with AWI "Architectural Woodwork Standards."

1. Provide labels and certificates from AWI certification program indicating that doors comply with requirements of grades specified.
 - a. This project has been registered with AWI as AWI Quality Certification Program Number 23.0620.
 - b. Contractor shall register the Work under this Section with the AWI Quality Certification Program at www.awiqcp.org or by calling 855-345-0991.
2. The Contract Documents contain requirements that are more stringent than the referenced quality standard. Comply with the Contract Documents in addition to those of the referenced quality standard.

2.4 SOLID-CORE FIVE-PLY FLUSH WOOD VENEER-FACED DOORS FOR TRANSPARENT FINISH

A. Interior Doors

1. Performance Grade: ANSI/WDMA I.S. 1A Extra Heavy Duty
2. Performance Grade:
 - a. ANSI/WDMA I.S. 1A Heavy Duty unless otherwise indicated on Drawings.
3. Architectural Woodwork Standards Grade: Custom.
4. Faces: Single-ply wood veneer not less than 1/50 inch thick.
 - a. Species: White Maple
 - b. Cut: Plain sliced (flat sliced)
 - c. Match between Veneer Leaves: Slip match.
 - d. Assembly of Veneer Leaves on Door Faces: Balance match.
 - e. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
 - f. Room Match: Match door faces within each separate room or area of building. Corridor-door faces do not need to match where they are separated by 10 feet or more.
 - g. Room Match: Provide door faces of compatible color and grain within each separate room or area of building.
5. Exposed Vertical Edges: Same species as faces or a compatible species.
 - a. Fire-Rated Single Doors: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed vertical edges.
 - b. Fire-Rated Pairs of Doors: Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.
 - c. Fire-Rated Pairs of Doors: Provide formed-steel edges and astragals with intumescent seals.
 - d. Mineral-Core Doors: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.
 - 1) Screw-Holding Capability: 550 lbf in accordance with WDMA T.M. 10.
6. Core for Non-Fire-Rated Doors:
 - a. ANSI A208.1, Grade LD-2 particleboard.
 - 1) Blocking: Provide wood blocking in particleboard-core doors as follows:
 - a) 5-inch top-rail blocking, in doors indicated to have closers.
 - b) 5-inch bottom-rail blocking, in exterior doors and doors indicated to have kick, mop, or armor plates.
 - 2) Provide doors with glued-wood-stave or WDMA I.S. 10 structural-composite-lumber cores instead of particleboard cores for doors scheduled to receive exit devices in Section 087100 "Door Hardware."
 - b. Glued wood stave.
 - c. WDMA I.S. 10 structural composite lumber.
 - 1) Screw Withdrawal, Door Face: 550 lbf.
 - 2) Screw Withdrawal, Vertical Door Edge: 550 lbf.
 - d. Either glued wood stave or WDMA I.S. 10 structural composite lumber.
7. Core for Fire-Rated Doors: As required to achieve fire-protection rating indicated on Drawings.
 - a. Blocking for Mineral-Core Doors: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated on Drawings as follows:
 - 1) 5-inch top-rail blocking.
 - 2) 5-inch bottom-rail blocking, in doors indicated to have protection plates.
 - 3) 5-inch midrail blocking, in doors indicated to have armor plates.
 - 4) 5-inch midrail blocking, in doors indicated to have exit devices.

8. Construction: Five plies, hot-pressed bonded (vertical and horizontal edging is bonded to core), with entire unit abrasive planed before veneering.

2.5 FABRICATION

- A. Factory fit doors to suit frame-opening sizes indicated.
 1. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
 2. Comply with NFPA 80 requirements for fire-rated doors.
- B. Factory machine doors for hardware that is not surface applied.
 1. Locate hardware to comply with DHI-WDHS-3.
 2. Comply with final hardware schedules, door frame Shop Drawings, ANSI/BHMA-156.115-W, and hardware templates.
 3. Coordinate with hardware mortises in metal frames, to verify dimensions and alignment before factory machining.
 4. For doors scheduled to receive electrified locksets, provide factory-installed raceway and wiring to accommodate specified hardware.
 5. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.
 6. Fabricate door and transom panels with full-width, solid-lumber[, rabbeted,] meeting rails.
 7. Provide factory-installed spring bolts for concealed attachment into jambs of metal door frames.
- C. Openings: Factory cut and trim openings through doors.
 1. Light Openings: Trim openings with moldings of material and profile indicated.
 2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 088000 "Glazing."
 3. Louvers: Factory install louvers in prepared openings.
- D. Exterior Doors: Factory treat exterior doors with water repellent after fabrication has been completed but before factory finishing.
 1. Flash top of outswinging doors with manufacturer's standard metal flashing.

2.6 FACTORY PRIMING

- A. Doors for Opaque Finish: Factory prime faces, all four edges, edges of cutouts, and mortises with one coat of wood primer specified in Section 099123 "Interior Painting."

2.7 FACTORY FINISHING

- A. Comply with referenced quality standard for factory finishing.
 1. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
 2. Finish faces, all four edges, edges of cutouts, and mortises.
 3. Stains and fillers may be omitted on top and bottom edges, edges of cutouts, and mortises.
- B. Factory finish doors that are indicated on Drawings to receive transparent finish.
- C. Transparent Finish:
 1. Architectural Woodwork Standards Grade: Custom.
 2. Finish: Architectural Woodwork Standards System-10, UV Curable, Water Based.
 3. Sheen: Satin.
- D. Opaque Finish:
 1. Architectural Woodwork Standards Grade: Custom.
 2. Finish: Architectural Woodwork Standards System-10, UV Curable, Water Based.
 3. Sheen: Satin.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and installed door frames, with Installer present, before hanging doors.
 1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
 2. Reject doors with defects.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Hardware: For installation, see Section 087100 "Door Hardware."

- B. Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.
- C. Install frames level, plumb, true, and straight.
 - 1. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches .
 - 2. Anchor frames to anchors or blocking built in or directly attached to substrates.
 - a. Secure with countersunk, concealed fasteners and blind nailing.
 - b. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork.
 - 1) For factory-finished items, use filler matching finish of items being installed.
 - 3. Install fire-rated doors and frames in accordance with NFPA 80.
 - 4. Install smoke- and draft-control doors in accordance with NFPA 105.
- D. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
- E. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.3 FIELD QUALITY CONTROL

- A. Inspection Agency: Owner will engage a qualified inspector to perform inspections and to furnish reports to Architect.
- B. Inspections:
 - 1. Provide inspection of installed Work through AWI's Quality Certification Program, certifying that wood doors and frames, including installation, comply with requirements of AWI/AWMCA/WI's "Architectural Woodwork Standards" for the specified grade.
 - 2. Fire-Rated Door Inspections: Inspect each fire-rated door in accordance with NFPA 80, Section 5.2.
 - 3. Egress Door Inspections: Inspect each door equipped with panic hardware, each door equipped with fire exit hardware, each door located in an exit enclosure, each electrically controlled egress door, and each door equipped with special locking arrangements in accordance with NFPA 101, Section 7.2.1.15.
- C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
- D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.
- E. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in NFPA 80 and NFPA 101.

3.4 ADJUSTING

- A. Operation: Rehang or replace doors that do not swing or operate freely.
- B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 081416

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SECTION 083113 – ACCESS DOORS AND FRAMES

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. This Section includes the following:
 - 1. Access doors and frames for walls and ceilings.

1.3 SUBMITTAL

- A. Product Data: For each type of access door and frame indicated. Include construction details, fire ratings, materials, individual components and profiles, and finishes.
- B. Shop Drawings: Show fabrication and installation details of access doors and frames for each type of substrate. Include plans, elevations, sections, details, and attachments to other work.
- C. Access Door and Frame Schedule: Provide complete access door and frame schedule, including types, locations, sizes, latching or locking provisions, and other data pertinent to installation.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain access door(s) and frame(s) through one source from a single manufacturer.
- B. Fire-Rated Access Doors and Frames: Units complying with NFPA 80 that are identical to access door and frame assemblies tested for fire-test-response characteristics per the following test method and that are listed and labeled by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
 - 1. NFPA 252 for vertical access doors and frames.
 - 2. NFPA 288 for horizontal access doors and frames.

1.5 COORDINATION

- A. Verification: Determine specific locations and sizes for access doors needed to gain access to concealed plumbing, mechanical, or other concealed work, and indicate in the schedule specified in "Submittals" Article.

PART 2 - PRODUCTS

2.1 ACCESS DOOR AND PANEL APPLICATIONS

- A. Walls, Unless Otherwise Indicated:
 - 1. Material: Steel.
 - 2. Size: 24x24 inches, unless otherwise indicated.
 - 3. Standard duty, hinged door.
 - 4. Hex key tool-operated spring or cam lock; no handle.
 - 5. In All Wall Types: Surface mounted face frame and door surface flush with frame surface.
 - 6. In Gypsum Board: Drywall bead frame with door surface flush with wall surface.
- B. Fire Rated Walls: See drawings for wall fire ratings.
 - 1. Material: Steel.
 - 2. Size: 24x24 inches, unless otherwise indicated.
 - 3. Insulated, double skin door panel.
 - 4. Hex key tool-operated spring or cam lock; no handle.
- C. Ceilings, Unless Otherwise Indicated: Same type as for walls.
 - 1. Material: Steel.
 - 2. Size in Other Ceilings: 24x24 inches, unless otherwise indicated.
 - 3. Hex key tool-operated spring or cam lock; no handle.
 - 4. In Gypsum Board ceiling: Drywall bead frame with door surface flush with ceiling surface.

2.2 ACCESS DOORS AND FRAMES FOR WALLS AND CEILINGS

- A. Manufacturers: Basis of Design Product: Provide Acudor Products Inc; Product AP5010: www.acudor.com. or comparable product by one of the following:
 - a. Acudor Products, Inc.
 - b. Babcock-Davis; A Cierra Products Co.
 - c. Cendrex Inc.
 - d. Jensen Industries.

- e. J. L. Industries, Inc.
 - f. Karp Associates, Inc.
 - g. Larsen's Manufacturing Company.
 - h. MIFAB, Inc.
 - i. Milcor Inc.
 - j. Nystrom, Inc.
 - k. Or approved equal.
- 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 units are to be installed in.
- 1. Style: Recessed door panel for infill with wall/ceiling finish.
 - a. In Gypsum Board: Use drywall bead type frame.
 - 2. Door Style: Single thickness with rolled or turned in edges.
 - 3. Frames: 16 gage, 0.0598 inch, minimum.
 - 4. Heavy Duty Single Thickness Steel Door Panels: 14 gage, 0.0747 inch, minimum.
 - 5. Double-Skinned Hollow Steel Door Panels: 16 gage, 0.059 inch, minimum, on both sides and all edges.
 - 6. Units in Fire Rated Assemblies: Fire rating as required by applicable code for the fire rated assembly in which they are to be installed.
 - a. Provide products listed and labeled by UL or ITS (Warnock Hersey) as suitable for the purpose specified and indicated.
 - 7. Hardware:
 - a. Hardware for Fire Rated Units: As required for listing.
 - b. Hinges for Non-Fire-Rated Units: Concealed, constant force closure spring type. Fire Rated, Uninsulated, Flush Access Doors and Frames with Exposed Trim: Fabricated from steel sheet.
 - 8. Locations: Wall surfaces.
 - 9. Fire-Resistance Rating: Not less than hourly rating of the wall or ceiling assembly.
 - 10. Door: Minimum 0.060-inch-thick sheet metal, flush construction.
 - 11. Frame: Minimum 0.060-inch-thick sheet metal with 1-inch-wide, surface-mounted trim.
 - 12. Hinges: Continuous piano.
 - 13. Automatic Closer: Spring type.
 - 14. Lock: Self-latching device with hex key lock.

2.3 FABRICATION

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of supports indicated.
 - 1. Exposed Flanges: As indicated.
 - 2. For trimless frames with drywall bead, provide edge trim for gypsum board securely attached to perimeter of frames.
 - 3. For trimless frames with plaster bead for full-bed plaster applications, provide zinc-coated expanded metal lath and exposed casing bead welded to perimeter of frames.
 - 4. Provide mounting holes in frames for attachment of units to metal or wood framing.
- D. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.
 - 1. Provide one hex key tool per door.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with manufacturer's written instructions for installing access doors and frames.
- B. Set frames accurately in position and attach securely to supports with plane of face panels aligned with adjacent finish surfaces.
- C. Install doors flush with adjacent finish surfaces or recessed to receive finish material.

3.2 ADJUSTING AND CLEANING

- A. Adjust doors and hardware after installation for proper operation.
- B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

END OF SECTION 083113

SECTION 08 70 00 – DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes finish hardware for the proper operation and control of all doors in the Project. Prior to bidding, notify Architect of any doors that do not have hardware meeting this intention.
- B. Hardware supplier will be responsible to furnish and install hardware on labeled doors to satisfy State and Local Building Codes.
- C. Related Sections include the following:
 - 1. Division 8 Section "Hollow Metal Doors and Frames."
 - 2. Division 8 Section "Flush Wood Doors."

1.3 SUBMITTALS

- A. Product Data: For each product and material indicated, submit manufacturer's technical product data. Include information necessary to show compliance with requirements, installation instructions and maintenance instructions.
- B. Hardware Schedule: Submit a hardware schedule organized into sets, including the information below. Designations for door numbers and hardware sets shall match those used in the construction documents.
 - 1. Opening Number
 - 2. Door Type and Size
 - 3. Frame Type and Size
 - 4. Frame Anchoring Method
 - 5. Hardware Set
 - 6. Assembly Rating
- C. Hardware Schedule shall be coordinated with the doors, frames and related work to ensure proper size, thickness, hand function and finish of door hardware

1.4 QUALITY ASSURANCE

- A. Supplier Qualifications: A recognized Architectural Finish Hardware Supplier, with warehousing facilities, who has been furnishing hardware in the Project's vicinity for a period of not less than two (2) years. Supplier shall be or employ an experienced Architectural Hardware Consultant (AHC) who is certified by and member of the Door and Hardware Institute. The Architectural hardware Consultant shall be available, at reasonable times during the course of the work, for consultation about Project's hardware requirements, to Owner, Architect and Contractor.
- B. Fire-Rated Openings: Provide hardware for fire-rated openings in compliance with NFPA Standard No. 80, No. 101 and local building code requirements. Provide only hardware, which has been tested and listed, by UL, FM or Warnock Hersey for types and sizes of doors required and complies with requirements of door and door frame labels.
- C. Standards: Comply with the requirements of the latest edition of the following standards unless indicated otherwise:

1. American National Standards Institute Publications:
 - a. A115 Series – Door and Frame Preparation
 - b. A156 Series – Hardware
2. Builders Hardware Manufacturer's Association Publications:
 - a. 1201 – Auxiliary Hardware
 - b. 1301 – Materials and Finishes
3. Door and Hardware Institute Publications:
 - a. Keying – Procedures, Systems and Nomenclature
 - b. Abbreviations and Symbols
 - c. Hardware for Labeled Fire Doors
 - d. Recommended Locations for Builder's Hardware for Standard and Custom Steel Doors and Frames
 - e. Wood Door Standards W1, W2, WDHS-2, WDHS-3
4. National Fire Protection Association Publications:
 - a. NFPA 80 – Standards for Fire Doors and Windows
 - b. NFPA 101 – Life Safety Code
5. International Building Code – 2015 Edition
6. American with Disabilities Act.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Package each hardware item in separate containers with all screws, wrenches, installation instructions and installation templates. Mark each box with hardware heading and door number according to approved hardware schedule.
- B. Deliver individually packaged hardware items at the proper times to the proper locations (shop or project site) for installation: Provide a complete packing list showing items, door numbers and hardware headings with each shipment.
- C. Store hardware in shipping cartons above ground and under cover to prevent damage. Provide secure lockup for door hardware delivered to the Project, but not yet installed. Control handling and installation of hardware items that are not immediately replaceable -so that completion of the Work will not be delayed by hardware losses both before and after installation.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not proceed with delivery and/or installation when ambient and substrate temperature conditions are outside limits permitted by material manufacturers.

PART 2 - PRODUCTS

2.1 HARDWARE GENERAL

- A. Provide the materials of products indicated by trade names, manufacturer's name, or catalog number. Substitutions will not be permitted except as described in Division 1.
- B. Provide manufacturer's standard products meeting the design intent of this Specification, free of imperfections affecting appearance or serviceability.
 1. Provide hardware complete with all fasteners, anchors, instructions, layout templates, and any specialized tools as required for satisfactory installation and adjustment.
 2. Hand of Door: Drawings show direction of slide, swing or hand of each door leaf. Furnish each item of hardware for proper installation and operation of door movement as shown.
 3. Furnish screws for installation with each hardware item. Provide Phillips flat head screws except as otherwise indicated or approved. Finish screws exposed under any condition to match hardware

- finish, or, if exposed in surface of other work, to match finish of such other work as closely as possible. Use machine screws for metal connections and wood screws for connections to wood. Use manufacturer's screws to secure hardware.
4. Provide concealed fasteners for hardware unit with care exposed when door is closed, except to extent no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt, head or nut on opposite face is exposed in other work, except where indicated otherwise or where it is not feasible to adequately reinforce the work. In such cases, provide sleeves for each thru-bolt or use sex screw fasteners.
 5. Special Tools: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance and removal and replacement of finish hardware.
- C. Hardware is specified in the hardware schedule by set, type and functions, which have been selected as best meeting the application requirements. Acceptable products for each category are specified in Paragraph 2.5 "Hardware Products".

2.2 SPECIAL REQUIREMENTS

- A. General:
1. Where new doors and hardware are scheduled to be installed in existing frames, contractor to coordinate hinge sizes and locations, lockset backsets, strikes, hardware mounting heights, etc with existing frames to ensure new door and hardware fits and functions properly in existing frame.
- B. Hinges:
1. Use heavy weight hinges for all doors.
- C. Locksets:
1. All locksets to be grade 1 heavy duty cylindrical or as specified.
- D. Closers:
1. Comply with manufacturer's recommendations for unit size based on door size and usage.
 2. Provide parallel arms for all overhead closers, except as otherwise indicated.
 3. All closers UL Listed Certified to be in compliance with UBC 7.2 and UL 10C.
 4. Closers with Pressure Relief Valves will not be acceptable.
 5. Supplier to provide any brackets or plates required for proper installation of door closers.
- E. Exit Devices:
1. All latchbolts to be deadlatching type.
 2. All touchbars to be stainless steel.

2.3 KEYING

- A. Contractor to turn all cylinders over to MU key shop for keying.

2.4 FINISHES

- A. Standard: Comply with BHMA A156.18
1. All door hardware to be US26D throughout project.
- B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the application units of hardware.
- C. Protect finishes on exposed surfaces from any damage by applying a strippable temporary protective

covering before shipping.

- D. BHMA Designations: Comply with base material and finish requirements indicated by BHMA standards.

2.5 HARDWARE PRODUCTS

ITEM	SPECIFIED	APPROVED EQUAL
Hinges	Ives	Stanley
Locksets	Schlage	Best, Corbin, Sargent
Cylinders	Best	No Substitution
Closers	LCN	Norton, Sargent, Stanley
Panic Devices	Von Duprin	Sargent, Yale, Precision
Flatgoods	Ives	Burns, Rockwood
Stops	Ives	Burns, Rockwood
Overhead Stops	Glynn Johnson	Rixson, ABH
Gasket	Zero	NGP, Reese
Electric Strikes	Adams Rite	Von Duprin, HES
Prox Card Readers	By Owner	By Owner
Auto Operators	Horton	Besam, LCN

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and frames with installer present for compliance with the requirements, for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Examine rough-in for electrical source power to verify actual locations of wiring connections before electrified door hardware installation.
- C. Notify Architect of any discrepancies or conflicts between the door schedule, door types, frame types, drawings, scheduled hardware and built condition.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Steel Frames: Comply with ANSI/DHI A115 Series
- B. Wood Doors: Comply with ANSI/DHI A115-W Series.

3.3 INSTALLATION

- A. Mounting Heights: Mount door hardware units at heights indicated in the following applicable publications, or as required to comply with governing regulations:
 - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 - 2. Custom Steel Doors and Frames: DHI's "Recommended Locations for Builder's Hardware for Custom Steel Doors and Frames."
 - 3. Wood Doors: DHI WDHS.2 "Recommended Locations for Architectural Hardware for Wood Flush Doors."
- B. Install each door hardware item to complete with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage and reinstallation of surface protective trim units to with finishing work. Do not install surface mounted items until finishes have been completed on substrates involved.

3.4 FIELD QUALITY CONTROL

- A. Field Inspection: Supplier will perform a final inspection of installed door hardware and state in written report whether work complies with or deviates from requirements, including whether door hardware is properly installed, operating and adjusted.

3.5 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating items of door hardware and each door to ensure proper operation of function of every unit. Replace units that cannot be adjusted to operate as intended and/or required. Adjust door control devices to compensation for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.6 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items as necessary to restore proper finish, and provide final protection and maintain condition that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMONSTRATION AND TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate and maintain door hardware and door hardware finishes.

3.8 DOOR HARDWARE SETS – RENOVATION OPTION 'M'

HARDWARE SET: 01

FOR USE ON DOOR #(S):

M727

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW	652	IVE
1	EA	PANIC HARDWARE	99-L-BE-17	626	VON
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	626	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

HARDWARE SET: 02

FOR USE ON DOOR #(S):

MV700

MW700

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW	652	IVE
1	EA	POWER TRANSFER	EPT10	689	VON
1	EA	ELEC FIRE EXIT HARDWARE	RX-LC-99-L-F-M996-17-FS	626	VON
1	EA	SFIC RIM HOUSING	80-129	626	SCH
1	EA	SFIC CORE	OWNER PROVIDED	626	BES
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	626	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	CARD READER	BY ACCESS CONTROL PROVIDER	BLK	SCE
1	EA	DOOR CONTACT	679-05 HM/WD AS REQ'D	BLK	SCE
1	EA	POWER SUPPLY	PS902 900-2RS-FA 120/240 VAC	LGR	SCE

OPERATION: DOOR NORMALLY CLOSED AND LOCKED ON STAIR SIDE. ENTRY TO FLOOR BY CARD READER, MOMENTARILY UNLOCKING LEVER TRIM. INSIDE PUSH PAD ALWAYS FREE EGRESS INTO STAIR.

NOTE: ELECTRIFIED LEVER TRIM TO AUTOMATICALLY UNLOCK UPON FIRE ALARM OR SIGNAL FROM FIRE COMMAND CENTER FOR STAIRWELL RE-ENTRY PER IBC.

HARDWARE SET: 03

FOR USE ON DOOR #(S):

M704

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW	652	IVE
1	EA	STOREROOM LOCK	ND80BD SPA	626	SCH
1	EA	SFIC CORE	OWNER PROVIDED	626	BES
1	EA	ELECTRIC STRIKE	6211 FSE 12/16/24/28 VAC/VDC	630	VON
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	626	IVE
1	EA	GASKETING	488SBK PSA (AT FIRE RATED DOORS)	BK	ZER
3	EA	SILENCER	SR64 (AT NON-RATED DOORS)	GRY	IVE
1	EA	CARD READER	BY ACCESS CONTROL PROVIDER	BLK	SCE
1	EA	DOOR CONTACT	679-05 HM/WD AS REQ'D	BLK	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 120/240 VAC	LGR	SCE

OPERATION: DOOR NORMALLY CLOSED AND LOCKED. ENTRY BY CARD READER, MOMENTARILY UNLOCKING ELECTRIC STRIKE. INSIDE LEVER ALWAYS FREE EGRESS.

HARDWARE SET: 04

FOR USE ON DOOR #(S):

M703

M705

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW	652	IVE
1	EA	STOREROOM LOCK	ND80BD SPA	626	SCH
1	EA	SFIC CORE	OWNER PROVIDED	626	BES
1	EA	ELECTRIC STRIKE	6211 FSE 12/16/24/28 VAC/VDC	630	VON
1	EA	SURFACE CLOSER	4040XP CUSH	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA (AT FIRE RATED DOORS)	BK	ZER
3	EA	SILENCER	SR64 (AT NON-RATED DOORS)	GRY	IVE
1	EA	CARD READER	BY ACCESS CONTROL PROVIDER	BLK	SCE
1	EA	DOOR CONTACT	679-05 HM/WD AS REQ'D	BLK	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 120/240 VAC	LGR	SCE

OPERATION: DOOR NORMALLY CLOSED AND LOCKED. ENTRY BY CARD READER, MOMENTARILY UNLOCKING ELECTRIC STRIKE. INSIDE LEVER ALWAYS FREE EGRESS.

HARDWARE SET: 05

FOR USE ON DOOR #(S):

M709

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW	652	IVE
1	EA	STOREROOM LOCK	ND80BD SPA	626	SCH
1	EA	SFIC CORE	OWNER PROVIDED	626	BES
1	EA	ELECTRIC STRIKE	6211 FSE 12/16/24/28 VAC/VDC	630	VON
1	EA	OH STOP	90S	630	GLY
1	EA	SURFACE CLOSER	4040XP	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA (AT FIRE RATED DOORS)	BK	ZER
3	EA	SILENCER	SR64 (AT NON-RATED DOORS)	GRY	IVE
1	EA	CARD READER	BY ACCESS CONTROL PROVIDER	BLK	SCE
1	EA	DOOR CONTACT	679-05 HM/WD AS REQ'D	BLK	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 120/240 VAC	LGR	SCE

OPERATION: DOOR NORMALLY CLOSED AND LOCKED. ENTRY BY CARD READER, MOMENTARILY UNLOCKING ELECTRIC STRIKE. INSIDE LEVER ALWAYS FREE EGRESS.

HARDWARE SET: 06

FOR USE ON DOOR #(S):

M705K

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW	652	IVE
1	EA	CLASSROOM LOCK	ND70BD SPA	626	SCH
1	EA	SFIC CORE	OWNER PROVIDED	626	BES
1	EA	WALL STOP	WS406/407CCV	626	IVE
3	EA	SILENCER	SR64	GRY	IVE

HARDWARE SET: 07

FOR USE ON DOOR #(S):

M705A

M705G

M705H

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW	652	IVE
1	EA	CLASSROOM LOCK	ND70BD SPA	626	SCH
1	EA	SFIC CORE	OWNER PROVIDED	626	BES
1	EA	SURFACE CLOSER	4040XP CUSH	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

HARDWARE SET: 08

FOR USE ON DOOR #(S):

M706 M707 M708

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW	652	IVE
1	EA	ENTRANCE LOCK	ND53BD SPA	626	SCH
1	EA	SFIC CORE	OWNER PROVIDED	626	BES
1	EA	WALL STOP	WS406/407CCV	626	IVE
3	EA	SILENCER	SR64	GRY	IVE

HARDWARE SET: 09

FOR USE ON DOOR #(S):

M705B M705C M705E M705F

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW	652	IVE
1	EA	PASSAGE SET	ND10S SPA	626	SCH
1	EA	WALL STOP	WS406/407CCV	626	IVE
3	EA	SILENCER	SR64	GRY	IVE

HARDWARE SET: 10

FOR USE ON DOOR #(S):

M719 M720

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW	652	IVE
1	EA	PUSH PLATE	8200 4" X 16"	630	IVE
1	EA	PULL PLATE	8305 10" 4" X 16"	630	IVE
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	626	IVE
3	EA	SILENCER	SR64	GRY	IVE

3.9 DOOR HARDWARE SETS – RENOVATION OPTION ‘L’

HARDWARE SET: 01

FOR USE ON DOOR #(S):

M727

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW	652	IVE
1	EA	POWER TRANSFER	EPT10	689	VON
1	EA	SFIC	OWNER PROVIDED	626	BES
1	EA	ELEC FIRE EXIT HARDWARE	RX-LC-QEL-99-L-F-17 24 VDC	626	VON
1	EA	SFIC RIM HOUSING	80-129	626	SCH
1	EA	SURFACE CLOSER	4040XP CUSH	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	CARD READER	BY ACCESS CONTROL PROVIDER	BLK	SCE
1	EA	DOOR CONTACT	679-05 HM/WD AS REQ'D	BLK	SCE
1	EA	POWER SUPPLY	PS902 900-2RS-FA 120/240 VAC	LGR	SCE

OPERATION: DOOR NORMALLY CLOSED AND LOCKED. ENTRY BY CARD READER, MOMENTARILY RETRACTING DEVICE LATCH. INSIDE PUSH PAD ALWAYS FREE EGRESS.

HARDWARE SET: 02

FOR USE ON DOOR #(S):

M704

M705

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW	652	IVE
1	EA	SFIC	OWNER PROVIDED	626	BES
1	EA	STOREROOM LOCK	ND80BD SPA	626	SCH
1	EA	ELECTRIC STRIKE	6211 FSE 12/16/24/28 VAC/VDC	630	VON
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	626	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
		(AT FIRE RATED DOORS)			
3	EA	SILENCER	SR64	GRY	IVE
		(AT NON-RATED DOORS)			
1	EA	CARD READER	BY ACCESS CONTROL PROVIDER	BLK	SCE
1	EA	DOOR CONTACT	679-05 HM/WD AS REQ'D	BLK	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 120/240 VAC	LGR	SCE

OPERATION: DOOR NORMALLY CLOSED AND LOCKED. ENTRY BY CARD READER, MOMENTARILY UNLOCKING ELECTRIC STRIKE. INSIDE LEVER ALWAYS FREE EGRESS.

NOTE: PROVIDE CLOSER WITH DELAYED ACTION FUNCTIONALITY AT DOOR M574 AND M401

HARDWARE SET: 03
FOR USE ON DOOR #(S):
M723A

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW	652	IVE
1	EA	SFIC	OWNER PROVIDED	626	BES
1	EA	STOREROOM LOCK	ND80BD SPA	626	SCH
1	EA	ELECTRIC STRIKE	6211 FSE 12/16/24/28 VAC/VDC	630	VON
1	EA	SURFACE CLOSER	4040XP CUSH	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA (AT FIRE RATED DOORS)	BK	ZER
3	EA	SILENCER	SR64 (AT NON-RATED DOORS)	GRY	IVE
1	EA	CARD READER	BY ACCESS CONTROL PROVIDER	BLK	SCE
1	EA	DOOR CONTACT	679-05 HM/WD AS REQ'D	BLK	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 120/240 VAC	LGR	SCE

OPERATION: DOOR NORMALLY CLOSED AND LOCKED. ENTRY BY CARD READER, MOMENTARILY UNLOCKING ELECTRIC STRIKE. INSIDE LEVER ALWAYS FREE EGRESS.

NOTE: PROVIDE CLOSER WITH DELAYED ACTION FUNCTIONALITY AT DOOR M648

HARDWARE SET: 04
FOR USE ON DOOR #(S):
M712

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW	652	IVE
1	EA	SFIC	OWNER PROVIDED	626	BES
1	EA	STOREROOM LOCK	ND80BD SPA	626	SCH
1	EA	ELECTRIC STRIKE	6211 FSE 12/16/24/28 VAC/VDC	630	VON
1	EA	SURFACE CLOSER	4040XP CUSH	689	LCN
1	EA	GASKETING	488SBK PSA	BK	ZER
1	SET	GASKETING	870AA-S	AA	ZER
1	EA	DOOR BOTTOM	361AA	AA	ZER
1	EA	THRESHOLD	545A-223	A	ZER
1	EA	CLOSER MOUNTING BRACKET	870SPB		ZER
1	EA	CARD READER	BY ACCESS CONTROL PROVIDER	BLK	SCE
1	EA	DOOR CONTACT	679-05 HM/WD AS REQ'D	BLK	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 120/240 VAC	LGR	SCE

OPERATION: DOOR NORMALLY CLOSED AND LOCKED. ENTRY BY CARD READER, MOMENTARILY UNLOCKING ELECTRIC STRIKE. INSIDE LEVER ALWAYS FREE EGRESS.

NOTE; PROVIDE CLOSER WITH DELAYED ACTION FUNCTIONALITY AT DOORS M547, M515, M646 AND M607-1

HARDWARE SET: 05

FOR USE ON DOOR #(S):

M700

PROVIDE EACH PR DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
6	EA	HINGE	5BB1HW	652	IVE
2	EA	POWER TRANSFER	EPT10	689	VON
1	EA	SFIC	OWNER PROVIDED	626	BES
1	EA	ELEC FIRE EXIT HARDWARE	RX-LC-9927-EO-F-LBR-499F	626	VON
1	EA	ELEC FIRE EXIT HARDWARE	RX-LC-QEL-9927-L-F-LBR-17-499F 24 VDC	626	VON
1	EA	SFIC RIM HOUSING	80-129	626	SCH
2	EA	SURFACE CLOSER	4040XP EDA	689	LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS	630	IVE
2	EA	WALL STOP	WS406/407CCV	626	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	ASTRAGAL (SET)	8193AA	AA	ZER
1	EA	CARD READER	BY ACCESS CONTROL PROVIDER	BLK	SCE
2	EA	DOOR CONTACT	679-05 HM/WD AS REQ'D	BLK	SCE
1	EA	POWER SUPPLY	PS902 900-2RS-FA 120/240 VAC	LGR	SCE

OPERATION: DOORS NORMALLY CLOSED AND LOCKED. ENTRY BY CARD READER,
MOMENTARILY RETRACTING DEVICE LATCH AT ACTIVE LEAF. INSIDE PUSH PADS ALWAYS FREE
EGRESS.

HARDWARE SET: 06

FOR USE ON DOOR #(S):

M708A2

M708A3

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW	652	IVE
1	EA	SFIC	OWNER PROVIDED	626	BES
1	EA	CLASSROOM LOCK	ND70BD SPA	626	SCH
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	626	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
		(AT FIRE RATED DOORS)			
3	EA	SILENCER	SR64	GRY	IVE
		(AT NON-RATED DOORS)			

HARDWARE SET: 07

FOR USE ON DOOR #(S):

M707A M708A1 M708A

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW	652	IVE
1	EA	SFIC	OWNER PROVIDED	626	BES
1	EA	CLASSROOM LOCK	ND70BD SPA	626	SCH
1	EA	SURFACE CLOSER	4040XP CUSH	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA (AT FIRE RATED DOORS)	BK	ZER
3	EA	SILENCER	SR64 (AT NON-RATED DOORS)	GRY	IVE

HARDWARE SET: 08

FOR USE ON DOOR #(S):

M710

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW	652	IVE
1	EA	SFIC	OWNER PROVIDED	626	BES
1	EA	CLASSROOM LOCK	ND70BD SPA	626	SCH
1	EA	OH STOP	90S	630	GLY
1	EA	SURFACE CLOSER	4040XP	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA (AT FIRE RATED DOORS)	BK	ZER
3	EA	SILENCER	SR64 (AT NON-RATED DOORS)	GRY	IVE

HARDWARE SET: 09

FOR USE ON DOOR #(S):

M711

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW	652	IVE
1	EA	SFIC	OWNER PROVIDED	626	BES
1	EA	ENTRANCE LOCK	ND53BD SPA	626	SCH
1	EA	WALL STOP	WS406/407CCV	626	IVE
3	EA	SILENCER	SR64	GRY	IVE

HARDWARE SET: 10
FOR USE ON DOOR #(S):
M708A4

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW	652	IVE
1	EA	SFIC	OWNER PROVIDED	626	BES
1	EA	ENTRANCE LOCK	ND53BD SPA	626	SCH
1	EA	SURFACE CLOSER	4040XP CUSH	689	LCN
1	EA	GASKETING	488SBK PSA	BK	ZER
1	SET	GASKETING	870AA-S	AA	ZER
1	EA	DOOR BOTTOM	361AA	AA	ZER
1	EA	THRESHOLD	545A-223	A	ZER
1	EA	CLOSER MOUNTING BRACKET	870SPB		ZER

HARDWARE SET: 11
FOR USE ON DOOR #(S):
M710A

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW	652	IVE
1	EA	PASSAGE SET	ND10S SPA	626	SCH
1	EA	WALL STOP	WS406/407CCV	626	IVE
3	EA	SILENCER	SR64	GRY	IVE

HARDWARE SET: 12
FOR USE ON DOOR #(S):
M710B

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW	652	IVE
1	EA	PASSAGE SET	ND10S SPA	626	SCH
1	EA	OH STOP	90S	630	GLY
3	EA	SILENCER	SR64	GRY	IVE

HARDWARE SET: 13

FOR USE ON DOOR #(S):

M707

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW	652	IVE
1	EA	PASSAGE SET	ND10S SPA	626	SCH
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	626	IVE
1	EA	GASKETING	488SBK PSA (AT RATED DOORS)	BK	ZER
3	EA	SILENCER	SR64 (AT NON-RATED DOORS)	GRY	IVE

HARDWARE SET: 14

FOR USE ON DOOR #(S):

M708

M708B1

M708B2

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW	652	IVE
1	EA	PASSAGE SET	ND10S SPA	626	SCH
1	EA	SURFACE CLOSER	4040XP CUSH	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA (at rated doors)	BK	ZER
3	EA	SILENCER	SR64 (at non-rated doors)	GRY	IVE

HARDWARE SET: 15

FOR USE ON DOOR #(S):

M706

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW	652	IVE
1	EA	PASSAGE SET	ND10S SPA	626	SCH
1	EA	OH STOP	90S	630	GLY
1	EA	SURFACE CLOSER	4040XP	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA (at rated doors)	BK	ZER
3	EA	SILENCER	SR64 (at non-rated doors)	GRY	IVE

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SECTION 088000 - GLAZING

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 glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
 - 1. Exterior Windows.
 - 2. Interior Doors.
 - 3. Interior sidelights
 - 4. Interior borrowed lites.
 - 5. Rated glazing.
 - 6. Glass film applied in field.

1.3 DEFINITIONS

- A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
- B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.
- C. Interspace: Space between lites of an insulating-glass unit.

1.4 PERFORMANCE REQUIREMENTS

- A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
 - 1. Temperature Change: 120 deg F ambient; 180 deg F, material surfaces.

1.5 ACTION SUBMITTALS

- A. Product Data: For each glass, glass film and glazing material indicated.
- B. Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches square.
 - 1. Insulating glass.
- C. Plastic Film Sample. mounted to 12 inches square clear glass sample.
- D. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

1.6 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For glass and glazing products, from manufacturer.
- B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for tinted glass coated glass insulating glass.
 - 1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.
- C. Warranties: Sample of special warranties.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved by coated-glass manufacturer.
- B. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
- C. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.
- D. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
- E. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 - 1. GANA Publications: GANA's "Laminated Glazing Reference Manual" and GANA's "Glazing Manual."
 - 2. IGMA Publication for Sloped Glazing: IGMA TB-3001, "Guidelines for Sloped Glazing."

3. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
 - F. Safety Glazing Labeling: Where safety glazing labeling is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
 - G. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.
- 1.8 DELIVERY, STORAGE, AND HANDLING**
- A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
 - B. Comply with insulating-glass manufacturer's written recommendations for venting and sealing units to avoid hermetic seal ruptures due to altitude change.
- 1.9 PROJECT CONDITIONS**
- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
 1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or below 40 deg F.
- 1.10 WARRANTY**
- A. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form in which insulating-glass manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GLASS PRODUCTS, GENERAL

- A. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to comply with requirements indicated.
 1. Minimum Glass Thickness for Exterior Lites: Not less than 6.0 mm.
 2. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.
- B. Strength: Where float glass is indicated, provide annealed float glass, Kind HS heat-treated float glass, or Kind FT heat-treated float glass. Where heat-strengthened glass is indicated, provide Kind HS heat-treated float glass or Kind FT heat-treated float glass. Where fully tempered glass is indicated, provide Kind FT heat-treated float glass.
- C. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data.
 1. For fire rated safety glazing properties are based on products of construction indicated.
 2. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
 3. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F.
 4. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
 5. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.2 INSULATING GLASS

- A. Insulating-Glass Units for use at exterior windows: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190, and complying with other requirements specified.
 1. Sealing System: Dual seal, with manufacturer's standard primary and secondary.
 2. Spacer: Manufacturer's standard spacer material and construction. Provide Black Anodic finish or match existing new glazing as directed by Owner and Architect.
 3. Desiccant: Molecular sieve or silica gel, or blend of both.
- B. Glass: Comply with applicable requirements in "Glass Products" Article as indicated by designations in "Insulating-Glass Types" Article.

2.3 GLAZING GASKETS

- A. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from one of the following:
 - 1. Neoprene complying with ASTM C 864.
 - 2. EPDM complying with ASTM C 864.
 - 3. Silicone complying with ASTM C 1115.
 - 4. Thermoplastic polyolefin rubber complying with ASTM C 1115.
- B. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned neoprene EPDM silicone or thermoplastic polyolefin rubber gaskets complying with ASTM C 509, Type II, black; of profile and hardness required to maintain watertight seal.
 - 1. Application: Use where soft compression gaskets will be compressed by inserting dense compression gaskets on opposite side of glazing or pressure applied by means of pressure-glazing stops on opposite side of glazing.

2.4 GLAZING SEALANTS

- A. General:
 - 1. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
 - 2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
 - 3. Sealants used inside the weatherproofing system, shall have a VOC content of not more than 250 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 4. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.

2.5 PLASTIC FILMS

- A. Glass Type: Plastic window film
 - 1. Applications: Interior glazing as indicated on drawings and finish schedule.
 - 2. Basis of design product 3M Window Films: Custom Design by Architect
www.3m.com/us/arch_construct/scpd/windowfilm
- B. Subject to review and approval by Architect, alternate manufacturer's which may be considered include:
 - 1. Designtex: www.designtex.com
 - 2. Decorative Films LLC: www.decorativefilm.com
 - 3. Flexvue Films: www.flexvuefilms.com
- C. Product: As indicated on Material Legend
- D. Provide custom cut window film panels on carrier medium.

2.6 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- D. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
- E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
- F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.
- G. Perimeter Insulation for Fire-Resistive Glazing: Product that is approved by testing agency that listed and labeled fire-resistant glazing product with which it is used for application and fire-protection rating indicated.

2.7 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
- B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.
- C. Grind smooth and polish exposed glass edges and corners.

2.8 MONOLITHIC GLASS SCHEDULE

- A. Glass Type: Clear fully tempered float glass. Provide where glass not required to be fire rated or insulated.

1. Minimum Thickness of Each Glass Ply: 1/4" (6 mm)
- B. General: Tempered Glazing Applications: Provide tempered safety glazing in the following locations:
 1. Glazed lites in doors except fire doors.
 2. Glazing adjacent to doors except in fire-rated walls and partitions.
 3. Other locations indicated on the drawings.
 4. Windows where glazing panel meets all of the following conditions:
 - a. Greater than 9 sq. ft.;
 - b. Bottom edge below 18 inches above the floor;
 - c. Top edge greater than 36 inches above floor; and
 - d. Within 36 inches horizontally of a walking surface.

2.9 INSULATING-GLASS TYPES

- A. **Glass Type IG-1:** Low-e-coated insulating glass with integral muntin between glass panels.
 1. Match tinting and appearance of existing insulated glazing units.
 2. Composition: Tint: 1/4" tinted bronze, 1/2" air space and 1/4: soft coat low-e clear SB60 on #3 surface.
 3. Manufacturer: subject to compliance with requirements: provide either of the following or approved equal.
 - a. Guardian Industries Corp: SN68
 - b. Pilkington: Energy Advantage
 - c. VITRO (formerly PPG) Solarban 60
 4. Overall Unit Thickness 1"
 5. Thickness of Each Lite: 1/4 -inch (6.0 mm.)
 6. Interspace Content: air.
 7. Perimeter Spacer: Aluminum with black, color anodic finish
 8. Integral muntin between glass panels. Coordinate with Aluminum Windows.
 9. Outdoor Lite: Class 1 annealed float glass.
 10. Indoor Lite: Class 1 annealed float glass. Tempered, if required by location.
 11. Low-E Coating: on no 3 surface.
- B. **Glass Type IG-2:** Low-e-coated, insulating glass for use at exterior windows.
 1. Match tinting and appearance of existing insulated glazing units.
 2. Composition: Tint: 1/4" tinted bronze, 1/2" air space and 1/4: soft coat low-e clear SB60 on #3 surface.
 3. Manufacturer: subject to compliance with requirements: provide either of the following or approved equal.
 - a. Guardian Industries Corp: SN68
 - b. Pilkington: Energy Advantage
 - c. VITRO (formerly PPG) Solarban 60
 4. Overall Unit Thickness 1"
 5. Thickness of Each Lite: 1/4 -inch (6.0 mm.)
 6. Interspace Content: air.
 7. Perimeter Spacer: Aluminum with black, color anodic finish
 8. Outdoor Lite: Class 1 annealed float glass.
 9. Indoor Lite: Class 1 annealed float glass. Tempered, if required by location.
 10. Low-E Coating: on no 3 surface.
- C. **Type IG-3 - Sealed Insulating Glass Units: Spandrel glazing**
 1. Application: exterior glazing where spandrel is indicated or required by Architect.
 2. Match tinting and appearance of existing insulated spandrel glazing units
 3. Overall Unit Thickness: 1"
 4. Thickness of each lite: 1/4" glass (6.0 mm)
 - a. Interspace Content: air.
 - b. Perimeter Spacer: Aluminum with black color anodic finish.
 5. Outboard Lite: Annealed float glass, 1/4 inch thick, minimum.
 - a. Tinted to match IG-1 glass
 - b. low-e coating on no 2 surface to match IG-1 glass
 6. Inboard Lite: Heat-strengthened float glass, 1/4 inch thick.
 - a. Tint: Clear.
 - b. Opacifier: Ceramic frit, on #4 surface. Color: bronze to match other spandrel.
 7. Glazing Method: Gasket glazing.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
 - 1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
 - 2. Present and functioning of weep systems.
 - 3. Minimum required face and edge clearances.
 - 4. Effective sealing between joints of glass-framing members.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
- B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that will leave visible marks in the completed work.

3.3 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Adjust glazing channel dimensions as required by Project conditions during installation to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.
- C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.
- D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- G. Provide spacers for glass lites where length plus width is larger than 50 inches.
 - 1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to 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.
- H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
- I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
- J. Set glass lites with proper orientation so that coatings face exterior or interior as specified.
- K. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
- L. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 GASKET GLAZING (DRY)

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
- C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

- D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

3.5 PLASTIC FILM INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Cut film edges neatly and square at a uniform distance of 1/8 inch to 1/16 inch of window sealant. Use new blade tips after 3 to 4 cuts.
- C. After application of film, wait time recommended by manufacturer and wash film using cleaning solutions approved by manufacturer. Do not use abrasive type cleaning agents and bristle brushes to avoid scratching film. Use synthetic sponges or soft cloths.

3.6 CLEANING AND PROTECTION

- A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.
- C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.
- D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.
- E. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

END OF SECTION 088000

SECTION 092116 - GYPSUM BOARD SHAFT WALL ASSEMBLIES

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: Gypsum board shaft wall assemblies.
- B. Related Sections:
 - 1. Section 072100 "Insulation" for Sound Attenuation / Acoustical Insulation.
 - 2. Section 079200 "Joint Sealants" for Acoustical Sealant.

1.3 ACTION SUBMITTALS

- A. Product Data: For each component of gypsum board shaft wall assembly.

1.4 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For shaft wall assemblies: firestop tracks, from ICC-ES.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.6 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or with gypsum board manufacturer's written recommendations, whichever are more stringent.
- B. Do not install interior products until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, moisture damaged, or mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- B. Low-Emitting Materials: Gypsum shaft wall assemblies shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.2 GYPSUM BOARD SHAFT WALL ASSEMBLIES

- A. Fire-Resistance Rating: As indicated
- B. Studs: Manufacturer's standard profile for repetitive members, corner and end members, and fire-resistance-rated assembly indicated.
 - 1. Depth: As indicated 4 inches and 6 inches.
 - 2. Minimum Base-Metal Thickness: 0.033 inch
- C. Runner Tracks: Manufacturer's standard J-profile track with manufacturer's standard long-leg length, but at least 2 inches long and matching studs in depth.
 - 1. Minimum Base-Metal Thickness: Matching steel studs
- D. Firestop Tracks: Provide firestop track at head of shaft wall on each floor level.
- E. Shaft-Side Finish: Gypsum shaft liner board, Type X
- F. Insulation: Sound attenuation blankets.

2.3 PANEL PRODUCTS

- A. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.
- B. Gypsum Shaft liner Board, Type X: ASTM C 1396/C 1396M; manufacturer's proprietary fire-resistive liner panels with paper faces.

1. Products: Subject to compliance with requirements, provide one of the following.
 - a. American Gypsum; Shaft Liner.
 - b. CertainTeed Corp.; ProRoc Shaftliner.
 - c. Georgia-Pacific Gypsum LLC, Subsidiary of Georgia Pacific; ToughRock Fireguard Shaftliner.
 - d. Lafarge North America, Inc.; Firecheck Type X Shaftliner.
 - e. National Gypsum Company; Gold Bond Brand Fire-Shield Shaftliner.
 - f. PABCO Gypsum; Pabcore Shaftliner Type X.
 - g. Temple-Inland Inc.; Fire-Rated SilentGuard Gypsum Shaftliner System.
 - h. USG Corporation; Sheetrock Brand Gypsum Liner Panel.
2. Thickness: 1 inch.
3. Long Edges: Double bevel.
- C. Gypsum Shaftliner Board, Moisture- and Mold-Resistant Type X: ASTM C 1396/C 1396M; manufacturer's proprietary fire-resistive liner panels with moisture- and mold-resistant core and surfaces.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; ProRoc Moisture and Mold Resistant Shaftliner.
 - b. Georgia-Pacific Gypsum LLC, Subsidiary of Georgia Pacific; Dens-Glass Ultra Shaftliner.
 - c. Lafarge North America, Inc.; Firecheck Moldcheck Type X Shaftliner.
 - d. National Gypsum Company; Gold Bond Brand Fire-Shield Shaftliner XP.
 - e. PABCO Gypsum; Pabcore Mold Curb Shaftliner Type X.
 - f. Temple-Inland Inc.; Fire-Rated SilentGuard TS Mold-Resistant Gypsum Shaftliner System.
 - g. USG Corporation; Sheetrock Brand Mold Tough Gypsum Liner Panel.
 2. Thickness: 1 inch.
 3. Long Edges: Double bevel.
 4. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
- D. Gypsum Board: As specified in Section 092900 "Gypsum Board."

2.4 NON-LOAD-BEARING STEEL FRAMING

- A. Steel Framing Members: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
 1. Protective Coating: ASTM A 653/A 653M, G60, unless otherwise indicated.
- B. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
 1. Products: Subject to compliance with requirements, provide one of the following
 - a. Fire Trak Corp.; Fire Trak System attached to studs with Fire Trak Posi Klip.
 - b. Grace Construction Products; FlameSafe FlowTrak System.
 - c. Metal-Lite, Inc.; The System.
 - d. Steel Network Inc. (The); VertiClip SLD VertiTrack VTD Series.

2.5 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with manufacturer's written recommendations.
- B. Trim Accessories: Corner bead, edge trim, and control joints of material and shapes as specified in Section 092900 "Gypsum Board" Section 092613 "Gypsum Veneer Plastering" that comply with gypsum board shaft wall assembly manufacturer's written recommendations for application indicated.
- C. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.
- D. Track Fasteners: Power-driven fasteners of size and material required to withstand loading conditions imposed on shaft wall assemblies without exceeding allowable design stress of track, fasteners, or structural substrates in which anchors are embedded.
 1. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing according to ASTM E 488 conducted by a qualified testing agency.
 2. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing according to ASTM E 1190 conducted by a qualified testing agency.
- E. Sound Attenuation Blankets: As specified in Section 072100 "Insulation"
- F. Acoustical Sealant: As specified in Section 079200 "Joint Sealants"

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates to which gypsum board shaft wall assemblies attach or abut, with Installer present, including hollow-metal frames, cast-in anchors, and structural framing. Examine for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, or mold damaged.

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

3.2 INSTALLATION

- A. General: Install gypsum board shaft wall assemblies to comply with requirements of fire-resistance-rated assemblies indicated, manufacturer's written installation instructions, and ASTM C 754 other than stud-spacing requirements.
- B. Do not bridge building expansion joints with shaft wall assemblies; frame both sides of expansion joints with furring and other support.
- C. Install supplementary framing in gypsum board shaft wall assemblies around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings, wall-mounted door stops, and similar items that cannot be supported directly by shaft wall assembly framing.
 - 1. Elevator Hoistway: At elevator hoistway-entrance door frames, provide jamb struts on each side of door frame.
 - 2. Reinforcing: Where handrails directly attach to gypsum board shaft wall assemblies, provide galvanized steel reinforcing strip with 0.033-inch minimum thickness of base metal (uncoated), accurately positioned and secured behind at least one layer of face panel.
- D. Penetrations: At penetrations in shaft wall, maintain fire-resistance rating of shaft wall assembly by installing supplementary steel framing around perimeter of penetration and fire protection behind boxes containing wiring devices, elevator call buttons, elevator floor indicators, and similar items.
- E. Isolate perimeter of gypsum panels from building structure to prevent cracking of panels, while maintaining continuity of fire-rated construction.
- F. Firestop Tracks: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
- G. Control Joints: Install control joints if not shown on drawings, according to ASTM C 840 and in specific locations approved by Architect while maintaining fire-resistance rating of gypsum board shaft wall assemblies.
- H. Cant Panels: At projections into shaft exceeding 4 inches where indicated, install 1/2- or 5/8-inch-thick gypsum board cants covering tops of projections.
 - 1. Slope cant panels at least 75 degrees from horizontal. Set base edge of panels in adhesive and secure top edges to shaft walls at 24 inches o.c. with screws fastened to shaft wall framing.
 - 2. Where steel framing is required to support gypsum board cants, install framing at 24 inches o.c. and extend studs from the projection to shaft wall framing.
- I. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.3 PROTECTION

- A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- B. Remove and replace panels that are wet, moisture damaged, or mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092116

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SECTION 092216 - NON-STRUCTURAL METAL FRAMING

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. Suspension systems for interior gypsum ceilings, and grid systems.
- B. Related Requirements:
 - 1. Section 061053 "Miscellaneous Rough Carpentry" for blocking and plywood panels inserted into wall assemblies.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 FRAMING SYSTEMS

- A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
 - 1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
 - 2. Protective Coating: ASTM A 653/A 653M, G40, hot-dip galvanized unless otherwise indicated.
- B. Cold-Rolled Channel Bridging: Steel, 0.053-inch minimum base-metal thickness, with minimum 1/2-inch-wide flanges.
 - 1. Depth: 1-1/2 inches.
 - 2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch-thick, galvanized steel.
- C. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
 - 1. Minimum Base-Metal Thickness: 0.027 inch.
 - 2. Depth: As indicated on Drawings.

2.2 SUSPENSION SYSTEMS

- A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch-diameter wire, or double strand of 0.048-inch-diameter wire.
- B. Hanger Attachments to Concrete:
 - 1. Anchors: Fabricated from corrosion-resistant materials with holes or loops for attaching wire hangers and capable of sustaining, without failure, a load equal to 5 times that imposed by construction as determined by testing according to ASTM E 488 by an independent testing agency.
 - a. Type: Postinstalled, chemical anchor or Postinstalled, expansion anchor.
 - 2. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by an independent testing agency.
- C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.
- D. Grid Suspension System for Gypsum Board Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Armstrong World Industries, Inc.; Drywall Grid System.
 - b. Chicago Metallic Corporation; Drywall Grid System.
 - c. USG Corporation; Drywall Suspension System.

2.3 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
 - 1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power and other properties required to fasten steel members to substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
 - 1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

3.3 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C 754.
 - 1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.
- B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- C. Install bracing at terminations in assemblies.
- D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING FRAMED ASSEMBLIES

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
 - 1. Single-Layer Application: 16 inches o.c. unless otherwise indicated.
 - 2. Multilayer Application: 16 inches o.c. unless otherwise indicated.
- B. Direct Furring:
 - 1. Screw to wood or metal framing.
 - 2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
- C. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.5 INSTALLING SUSPENSION SYSTEMS

- A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
 - 1. Hangers: 48 inches o.c.
 - 2. Carrying Channels (Main Runners): 48 inches o.c.
 - 3. Furring Channels (Furring Members): 16 inches o.c.
- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- C. Suspend hangers from building structure as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
 - a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
 - a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
 - 3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 - 4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 - 5. Do not attach hangers to steel roof deck.

6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
 7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
 8. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- D. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
- E. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 092216

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SECTION 092900 - GYPSUM BOARD

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. Interior ceiling gypsum board.
 - 2. Interior gypsum board.
 - 3. Abuse resistant gypsum board for use at lower 48" of corridor walls and where otherwise indicated.
 - 4. Moisture resistant gypsum board.
- B. Related Requirements:
 - 1. Section 092216 "Non-Structural Metal Framing" for suspension systems that support gypsum board panels.

1.3 ACTION SUBMITTALS

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

1.4 QUALITY ASSURANCE

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

1.5 STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against damage from weather, condensation, direct sunlight, construction traffic, and other causes. Stack panels flat to prevent sagging.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.
- B. Do not install interior products until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PANELS, GENERAL

- A. Size: Provide in maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.2 INTERIOR GYPSUM BOARD

- A. General: Complying with ASTM C 36/C 36M or ASTM C 1396/C 1396M, as applicable to type of gypsum board indicated and whichever is more stringent.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - American Gypsum Co.
 - G-P Gypsum.
 - Lafarge North America Inc.
 - National Gypsum Company.
 - USG Corporation.
- B. Gypsum Board, Type X: ASTM C 1396/C 1396M
 - Basis of Design: USG Ecosmart Panels Firecode X
 - 1. Thickness: 5/8 inch.
 - 2. Long Edges: Tapered.

- C. Ceiling Type: Manufactured to have more sag resistance than regular-type gypsum board.
 - 1. Thickness: 1/2 inch.
 - 2. Long Edges: Tapered.
- D. Moisture- and Mold-Resistant Type: With moisture- and mold-resistant core and surfaces.
 - 1. Core: 5/8 inch, Type X.
 - 2. Long Edges: Tapered.
- E. Shaftliner: Gypsum Shaftliner Board, Moisture- and Mold-Resistant Type X: ASTM C 1396/C 1396M; manufacturer's proprietary fire-resistive liner panels with moisture- and mold-resistant core and surfaces.
 - Core: 1 inch (25.4 mm)
 - Long Edges: Double bevel
 - Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

2.3 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.
 - 1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
 - 2. Shapes:
 - Cornerbead.
 - LC-Bead: J-shaped; exposed long flange receives joint compound.
 - L-Bead: L-shaped; exposed long flange receives joint compound.
 - U-Bead: J-shaped; exposed short flange does not receive joint compound.
 - Expansion (control) joint.
 - Curved-Edge Cornerbead: With notched or flexible flanges.

2.4 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475/C 475M.
- B. Joint Tape:
 - 1. Interior Gypsum Wallboard: Paper.
- C. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
 - 1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
 - 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
 - Use setting-type compound for installing paper-faced metal trim accessories.
 - 3. Fill Coat: For second coat, use setting-type, sandable topping compound.
 - 4. Finish Coat: For third coat, use drying-type, all-purpose compound.
 - 5. Skim Coat: For final coat of Level 5 finish, use drying-type, all-purpose compound.

2.5 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
 - 1. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
 - 1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
 - 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames and framing, for compliance with requirements and other conditions affecting performance.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C 840.

- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
 - 2. Fit gypsum panels around ducts, pipes, and conduits.
 - 3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch wide spaces at these locations, and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

3.3 APPLYING INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
 - 1. Type X: Where required for fire-resistance-rated assembly and all vertical surfaces, unless otherwise indicated.
 - 2. Ceiling Type: Ceiling surfaces.
 - 3. Moisture- and Mold-Resistant Type: In the bathrooms, break room, janitor's closet, and on the interior face of all exterior walls that receive a gypsum board finish.
- B. Single-Layer Application:
 - 1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing, unless otherwise indicated.
 - 2. On partitions/walls, apply gypsum panels horizontally (perpendicular to framing), unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
 - 3. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
 - 4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.
- C. Abuse-Resistant Type: at lower 48 inches of hallways/corridors.
- D. Multilayer Application:
 - 1. On ceilings, apply gypsum board indicated for base layers before applying face layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints 1 framing member, 16 inches minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
 - 2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
 - 3. On Z-furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
 - 4. Fastening Methods: Fasten base layers and face layers separately to supports with screws.
- E. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written recommendations and temporarily brace or fasten gypsum panels until fastening adhesive has set.

3.4 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints at locations indicated on Drawings and according to ASTM C 840 and in specific locations approved by Architect for visual effect. Control joints shall be no more than 30'-0 max. distance apart horizontal and 15'-0 max. distance apart vertical. Architect to verify locations.

- C. Interior Trim: Install in the following locations:
 - 1. Cornerbead: Use at outside corners.
 - 2. U-Bead: Use at exposed panel edges.

3.5 FINISHING GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
 - 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
 - a. Concealed areas may include areas where permanent equipment blocks view. Does not include areas concealed by other finishes.
 - 2. Level 4: At panel surfaces that will be exposed to view, unless otherwise indicated.
Primer and its application to surfaces are specified in other Division 09 Sections.

3.6 PROTECTION

- A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- B. Remove and replace panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092900

SECTION 09 30 13 - CERAMIC TILING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Porcelain tile.
 - 2. Glazed wall tile.
 - 3. Waterproof membrane for thinset applications.
 - 4. Metal edge strips.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples:
 - 1. Each type and composition of tile and for each color and finish required. For ceramic mosaic tile in color blend patterns, provide samples of each color blend.
 - 2. Grout joints

1.3 INFORMATIONAL SUBMITTALS

- A. Product Certificates: Buy America Compliance Worksheet, as required by Project Contract Documents.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer's supervisor for Project holds the International Masonry Institute's Foreman Certification.

PART 2 - PRODUCTS

2.1 PRODUCTS, GENERAL

- A. ANSI Ceramic Tile Standard: Provide Standard-grade tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

2.2 TILE PRODUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Virginia Tile
 - 2. Sunderlands
 - 3. Mirage
 - 4. American Olean
 - 5. Daltile
 - 6. Or approved equal.
 - a. Approved equals MUST be approved during bidding and be listed as approved in an addendum. It is the responsibility of the requestor to provide ample enough information (such as CSI Form 13.1A) to prove equality of requested "equal". If insufficient data is provided, substitution / approved equal request will be rejected.
- B. Certification: Tile certified by the Porcelain Tile Certification Agency
- C. Ceramic Tile Type: Unglazed porcelain tile.
 - 1. Face Size: As indicated in the Drawings.
 - 2. Face: Plain with modified square edges
 - 3. Dynamic Coefficient of Friction: Not less than 0.42.
 - 4. Tile Pattern: As indicated in the Drawings.
 - 5. Grout Size: As indicated in the Drawings.
 - 6. Grout Color: As selected by Architect from manufacturer's full range.
 - 7. Trim Units: Refer to Metal Edge Strips below for additional units. Coordinate as necessary.
- D. Ceramic Tile Type: Glazed wall tile.
 - 1. Basis of Design: As indicated in the Drawings

2. Module Size: As indicated on the Drawings
3. Face: Plain with modified square edges
4. Finish: Bright, Opaque
5. Tile Pattern: Stack
6. Grout Color: As selected by Architect from manufacturer's full range.
7. Grout Size: As indicated in the Drawings.
8. Mounting: Back mounted.
9. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
 - a. Base: Coved, module size, matching tile size of adjoining flat.
 - b. Internal Corners: Field-buttet square corners. For coved base and cap use angle pieces designed to fit with stretcher shapes.
 - c. Refer to Metal Edge Strips below for additional units. Coordinate as necessary.

2.3 WATERPROOF MEMBRANE

- A. General: Manufacturer's standard product, that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

2.4 CRACK ISOLATION MEMBRANE

- A. General: Manufacturer's standard product that complies with ANSI A118.12 for high performance and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

2.5 SETTING MATERIALS

- A. Provide setting materials in accordance with requirements specified herein and in accordance with manufacturers printed installation instructions or as directed by manufacturers Technical Representative
- B. Standard Dry-Set Mortar (Thinset): ANSI A118.1.
 1. For wall applications, provide nonsagging mortar.

2.6 GROUT MATERIALS

- A. Provide grout materials in accordance with requirements specified herein and in accordance with manufacturers printed installation instructions or as directed by manufacturers Technical Representative.
- B. Sand-Portland Cement Grout: ANSI A108.10, consisting of white or gray cement and white or colored aggregate as required to produce color indicated.
- C. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
- D. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

2.7 MISCELLANEOUS MATERIALS

- A. Metal Edge Strips: Angle or L-shape, height to match tile and adjacent material and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for tile transition conditions.
 1. Outside Corners:
 - a. Basis of Design:
 - 1) Schluter QUADEC
 - b. Material: Extruded Aluminum
 - c. Installation: at all outside corners of tile.
 - d. Finish/Color: To be selected by Architect from Manufacturer's standard range.
 2. Edge Protection:
 - a. Basis of Design:
 - 1) Schluter QUADEC
 - b. Material: Extruded Aluminum
 - c. Installation: at all vertical and horizontal exposed termination edges of tile.
 - d. Finish/Color: To be selected by Architect from Manufacturer's standard range.
 3. Floor Transition: Refer to 09 68 13 "Tile Carpeting" for metal transition strip at tile locations.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thinset mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
- B. Where indicated, prepare substrates to receive waterproof membrane by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot (1:50) toward drains.
- C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 INSTALLATION

- A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
- B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.
- E. Where accent tile differs in thickness from field tile, vary setting bed thickness so that tiles are flush.
- F. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
- G. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
 - 1. Glazed Wall Tile: As indicated on the Drawings. Porcelain Tile: As indicated on the Drawings.
- H. Fit tile units around corners, fitments, fixtures, drains and other built-in-objects to maintain uniform joint appearance. Cut, drill and set anchors, bolts for fastening fixtures and fittings in tile work. Make cut edges smooth, even and free from chipping. Do not split tile
- I. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.
- A. Expansion and Control Joints:
 - 1. Carry existing movement joints all the way through from substrate surface layer including tiling surface. Ensure control and expansion joints are kept free of setting materials.
 - 2. Install control joints where tiling abuts restraining surfaces, around perimeter of work (and or panel) and at base of columns and curbs.
 - 3. Install and space expansion and control joints in accordance with following:
 - a. interior: 16' (4878 mm) to 20' (6098 mm) in each direction with minimum joint width of 6 mm (1/4").
 - b. interior exposed to direct sunlight or moisture: 8' (2439 mm) to 12' (3659 mm) in each direction with minimum joint width of 1/4" (6 mm).
 - c. exterior - normal: 8' (2439 mm) to 12' (3659 mm) in each direction with minimum joint width of 3/8" (9 mm).
 - d. exterior - excessive: 8' (2439 mm) to 10' (3049 mm) in each direction with minimum joint width of 1/2" (13 mm).
- B. Metal Edge Strips: Install at exposed edge of tile as previously noted.
- C. Install tile backing panels and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated.
- D. Install waterproof membrane to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.

3.4 INTERIOR CERAMIC TILE INSTALLATION SCHEDULE

- A. Interior Floor Installations, Concrete Subfloor:
 - 1. Ceramic Tile Installation: TCNA F111 and ANSI A108.1B; cement mortar bed (thickset) with cleavage membrane.
 - a. Ceramic Tile Type: As indicated in the Drawings.
 - b. Bond Coat for Cured-Bed Method: Standard dry-set mortar.
 - c. Grout: Sand-portland cement grout.
- B. Interior Wall Installations, Wood or Metal Studs or Furring:
 - 1. Ceramic Tile Installation TCNA W221 and ANSI A108.1B cement mortar bed (thickset) over waterproof membrane on solid backing.
 - a. Ceramic Tile Type: As indicated in the Drawings.
 - b. Bond Coat for Cured-Bed Method: Standard dry-set mortar.
 - c. Grout: Sand-portland cement grout.

END OF SECTION 09 30 13

SECTION 095113 - ACOUSTICAL TILE CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Acoustical tiles for interior ceilings.
 - 2. Fully concealed, direct-hung, suspension systems.
 - 3. Direct-glued acoustical panels
- B. Related Requirements:

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, and coordinated with each other, using input from installers of the items involved.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: Class A according to ASTM E1264.
 - 2. Smoke-Developed Index: 50 or less.

2.2 ACOUSTICAL TILES,

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Armstrong World Industries
 - 2. Rockfon North America
 - 3. USG Corporation
 - 4. Or approved equal.
 - a. Approved equals MUST be approved during bidding and be listed as approved in an addendum. It is the responsibility of the requestor to provide ample enough information to prove equality of requested "equal". If insufficient data is provided, substitution / approved equal request will be rejected.

2.3 ACOUSTICAL TILES ACT-1

- A. Basis of Design:
 - 1. As indicated on the Drawings
- B. Acoustical Tile Standard: Manufacturer's standard tiles of configuration indicated that comply with ASTM E1264, Class III.
- C. Color: As indicated on Drawings
- D. Light Reflectance (LR): .80
- E. Ceiling Attenuation Class (CAC): 35
- F. Noise Reduction Coefficient (NRC):.55
- G. Edge/Joint Detail: As indicated on Drawings
- H. Thickness: 5/8 inch.
- I. Modular Size: As indicated on Drawings

2.4 ACOUSTICAL TILES ACT-2

- A. Basis of Design:
 - 1. As indicated on the Drawings
- B. Acoustical Tile Standard: Manufacturer's standard tiles of configuration indicated that comply with ASTM E1264, Class 100.
- C. Color: As indicated on Drawings
- D. Light Reflectance (LR): .79
- E. Ceiling Attenuation Class (CAC): 35
- F. Noise Reduction Coefficient (NRC): N/A
- G. Edge/Joint Detail: As indicated on Drawings

- H. Thickness: 5/8 inch.
- I. Modular Size: As indicated on Drawings

2.5 METAL SUSPENSION SYSTEM

- A. Basis of Design:
 - 1. Armstrong Ceiling and Wall Solutions
 - 2. Width: 9/16"
- B. Metal Suspension-System Standard: Manufacturer's standard, direct-hung, fully concealed, metal suspension system that complies with applicable requirements in ASTM C635/C635M.
- C. Direct-Hung, Double-Web Suspension System: Main and cross runners roll formed from and capped with cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized, G30 (Z90) coating designation.
 - 1. Structural Classification: Intermediate duty system.
 - 2. Access: Upward, with initial access openings of size indicated below and located throughout ceiling within each module formed by main and cross runners, with additional access available by progressively removing remaining acoustical tiles.
 - a. Initial Access Opening: In each module, 24 by 24 inches (610 by 610 mm).
- D. System to be utilized for tile ceiling, as noted above, as well as hung gyp ceilings, as noted in the drawings.

2.6 SOUND-ABSORBING CEILING PANEL – ACT-3

- A. Manufacturer's standard panel construction. Basis-of-Design Product: SONEX Acoustical Products, SONEXone or comparable product from approved manufacturer.
 - 1. Mounting: Back mounted with manufacturer's standard adhesive, secured to substrate.
 - 2. Core: Manufacturer's standard open cell melamine foam
 - 3. Edge Construction: Manufacturer's standard self-edge.
 - 4. Edge Profile: Beveled.
 - 5. Reveals between Panels: Flush Reveals
 - 6. Acoustic Performance: Sound absorption NRC of 0.50 to 0.90 according to ASTM C 423 for mounting according to ASTM E 795
 - 7. Nominal Thickness: 2"
 - 8. Panel Width & Height: Per drawings.

2.7 ACCESSORIES

- A. Attachment Devices: Size for five times the design load indicated in ASTM C635/C635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
- B. Seismic Clips: Manufacturer's standard seismic clips designed to secure acoustical tiles in-place during a seismic event.

2.8 METAL EDGE MOLDINGS AND TRIM

- A. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations complying with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for of suspension-system runners.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical tiles to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width tiles at borders unless otherwise indicated.
- B. Layout openings for penetrations centered on the penetrating items.

3.2 INSTALLATION OF SUSPENDED ACOUSTICAL TILE CEILINGS

- A. Install suspended acoustical tile ceilings according to ASTM C636/C636M seismic design requirements, and manufacturer's written instructions.
- B. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical tiles.
 - 1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
 - 2. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- C. Arrange directionally patterned acoustical tiles as indicated on reflected ceiling plans.

3.3 SOUND ABSORBING CEILING UNIT INSTALLATION

- A. Install sound-absorbing ceiling units in locations indicated with edges plumb, level and in alignment with other units, faces flush, and scribed to fit adjoining work accurately at borders and penetrations.

- B. Comply with sound-absorbing wall unit manufacturer's written instructions for installation of units using type of mounting device indicated. Mount units securely to supporting substrate.
- C. Align and level fabric pattern and grain among adjacent units.
- D. Variation from Plumb and Level: Plus or minus 1/16" (1.6mm).
- E. Variation of Panel Joints from Hairline: Not more than 1/16 inch (1.6mm) wide.

END OF SECTION 095113

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SECTION 096513 - RESILIENT BASE AND ACCESSORIES

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. Resilient base.
 - 2. Resilient molding accessories.
- B. Related Sections:
 - 1. Section 090561 "Common Work Results For Flooring Preparation".
 - 2. Section 096519 "Resilient Tile Flooring".

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Verification: For each type of product indicated and for each color, texture, and pattern required in manufacturer's standard-size Samples, but not less than 12 inches long.
- C. Product Schedule: For resilient base and accessory products. Use same designations indicated on Drawings.

1.4 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. Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.

1.6 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient products during the following time periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 THERMOSET-RUBBER BASE: RB-1

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Johnsonite Traditional Rubber Wall Base as indicated on Drawings, or comparable product by one of the following:
 - 1. Flexco, Inc.
 - 2. Roppe Corporation
- B. Product Standard: ASTM F 1861, Type TS (rubber, vulcanized thermoset), Group I (solid, homogeneous).
 - 1. Style and Location:
 - a. Style B, Cove: Provide in areas with resilient flooring or sealed concrete.
- C. Thickness: 0.125 inch.
- D. Height: 4 inches.
- E. Lengths: Coils in manufacturer's standard length.
- F. Outside Corners: Job formed.
- G. Inside Corners: Job formed.
- H. Colors: as indicated on Finish Legend on drawings.

2.2 RUBBER MOLDING ACCESSORY RT-1

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Johnsonite, Transition #CTA-XX-J.
- B. Description: Transition from luxury vinyl tile flooring to concrete flooring.
- C. Profile and Dimensions: As indicated.
- D. Locations: Refer to finish plan.
- E. Colors and Patterns: as selected by Architect from manufacturer's full range.

2.3 RUBBER MOLDING ACCESSORY RT-2

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Johnsonite, Adapter #CTA-XX-A.
- B. Description: Transition from luxury vinyl tile flooring to existing VCT flooring. Transition from luxury vinyl tile flooring to carpeted flooring.
- C. Profile and Dimensions: As indicated or required.
- D. Locations: Refer to finish plan.
- E. Colors and Patterns: As selected by Architect from manufacturer's full range.

2.4 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
 - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- C. Do not install resilient products until they are the same temperature as the space where they are to be installed.
 - 1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.
- D. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.3 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required. Extend base into knee spaces and behind equipment.
- C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- E. Do not stretch resilient base during installation.
- F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
- G. Job-Formed Corners:
 - 1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
 - a. Form without producing discoloration (whitening) at bends.

2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
 - a. Miter corners to minimize open joints.

3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.
- B. Perform the following operations immediately after completing resilient-product installation:
 1. Remove adhesive and other blemishes from exposed surfaces.
 2. Sweep and vacuum horizontal surfaces thoroughly.
 3. Damp-mop horizontal surfaces to remove marks and soil.
- C. Protect resilient products from marks, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 096513

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SECTION 096519 - RESILIENT TILE FLOORING

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. Luxury vinyl floor tile.
- B. Related Sections:
 - 1. Section 096513 "Resilient Base and Accessories"

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For each type of floor tile. Include floor tile layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
 - 1. Show details of special patterns.
- C. Samples for Verification: Full-size units of each color and pattern of floor tile required.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of floor tile to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs workers for this Project who are competent in techniques required by manufacturer for floor tile installation and seaming method indicated.
 - 1. Engage an installer who employs workers for this Project who are trained or certified by floor tile manufacturer for installation techniques required.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store floor tile and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F. For more than 90 deg F. Store floor tiles on flat surfaces.

1.8 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive floor tile during the following time periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Close spaces to traffic during floor tile installation.
- D. Close spaces to traffic for 48 hours after floor tile installation.
- E. Install floor tile after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For resilient tile flooring, as determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
 - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

2.2 LUXURY VINYL FLOOR TILE: LVT-1

- A. Basis of Design Product: provide Interface "Walk of Life "
- B. Thickness: 4.5mm
- C. Size: 50cm x 50cm
- D. Colors and Patterns: refer to Material Legend on drawings for color selection. refer to Finish Plan for floor pattern.

2.3 LUXURY VINYL FLOOR TILE: LVT-2

- A. Basis of Design Product: Mohawk Group – Hot and Heavy; Bolder. Subject to compliance with requirements, provide products listed in material legend.
- B. Tile Standard: ASTM F 1700.
 - 1. Type: A, smooth surface.
- C. Thickness: 0.20 inch (5mm).
- D. Size: 36 by 36 inches.
- E. Two colors as indicated on drawings.
- F. Colors and Patterns: refer to Material Legend on drawings for color selections. refer to Finish Plan for floor pattern.

2.4 VINYL COMPOSITION TILE: XVCT-1

- A. Basis of Design Product: Armstrong Flooring Standard Excelon Imperial Texture. Subject to compliance with requirements, provide products listed in material legend.
- B. Tile Standard: ASTM F1066 – Class 2 through pattern.
 - 1. ISO 10595, Type II
- C. Wearing Surface: Smooth
- D. Thickness: 1/8 inch (3.2mm).
- E. Size: 12 by 12 inches.
- F. Colors and Patterns: refer to Material Legend on drawings for color selections. refer to Finish Plan for floor pattern.

2.5 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by floor tile manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.
 - 1. Adhesives shall comply with the following limits for VOC content:
 - a. 50 g/L or less.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
 - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor tile.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to floor tile manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates: Prepare according to ASTM F 710.
 - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 - 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by floor tile manufacturer. Do not use solvents.
 - 3. Alkalinity and Adhesion Testing: Perform tests recommended by floor tile manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
 - 4. Moisture Testing: Proceed with installation only after substrates pass testing according to floor tile manufacturer's written recommendations, but not less stringent than the following:
 - a. Perform relative humidity test using in situ probes according to ASTM F 2170. Proceed with installation only after levels are suitable per Manufacturer's recommendations.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install floor tiles until they are the same temperature as the space where they are to be installed.
 - 1. At least 48 hours in advance of installation, move resilient floor tile and installation materials into spaces where they will be installed.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile.

3.3 FLOOR TILE INSTALLATION

- A. Comply with manufacturer's written instructions for installing floor tile.
- B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
 - 1. Lay tiles in pattern indicated on Finish Plan.
- C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.
 - 1. Lay tiles in pattern of colors and sizes indicated on Finish Plan.
- D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
- E. Extend floor tiles into toe spaces, knee spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.
- G. Adhere floor tiles to flooring substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
- H. A perimeter glue and floating installation is not acceptable.

3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting floor tile.
- B. Perform the following operations immediately after completing floor tile installation:
 - 1. Remove adhesive and other blemishes from exposed surfaces.
 - 2. Sweep and vacuum surfaces thoroughly.
 - 3. Damp-mop surfaces to remove marks and soil.
- C. Protect floor tile from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Cover floor tile until Substantial Completion.

END OF SECTION 096519

SECTION 096723 - RESINOUS FLOORING

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. Resinous flooring.
 - 2. Integral cove base accessories.
- B. Section 090561 "Common Work Results For Flooring Preparation"
- C. Section 096519 "Resilient Tile Flooring"

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review manufacturer's written instructions for substrate preparation and environmental conditions affecting resinous flooring installation.
 - 2. Review details of integral cove bases.
 - 3. Review manufacturer's written instructions for installing resinous flooring systems.
 - 4. Review protection measures for adjacent construction and installed flooring, floor drainage requirements, curbs, base details, and so forth.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include manufacturer's technical data, installation instructions, and recommendations for each resinous flooring component required.
- B. Samples: For each resinous floor system required and for each color and texture specified, 6 inches (150 mm) square in size, applied to a rigid backing by Installer for this Project.
- C. Samples for Initial Selection: For each type of exposed finish required.
- D. Samples for Verification: For each resinous flooring system required and for each color and texture specified, 6 inches (150 mm) square, applied to a rigid backing by Installer for this Project.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Material Certificates: For each resinous flooring component.
- C. Material Test Reports: For each resinous flooring system, by a qualified testing agency.
- D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For resinous flooring to include in maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
 - 1. Engage an installer who is certified in writing by resinous flooring manufacturer as qualified to apply resinous flooring systems indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring installation.
- B. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring installation.
- C. Close spaces to traffic during resinous flooring installation and for 24 hours after installation unless manufacturer recommends a longer period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Flammability: Self-extinguishing in accordance with ASTM D635.

2.2 RESINOUS FLOORING <EPF-1>

- A. Resinous Flooring System: Abrasion-, impact-, and chemical-resistant, aggregate-filled, resin-based monolithic floor surfacing designed to produce a seamless floor and integral cove base.
1. Basis of Design: Desco Industries: Desco Industrial Series CA, CR or similar products from the following manufacturers;
 2. Tnemec
 3. Dur-a-guard
- B. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, from single source from single manufacturer. Obtain secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from manufacturer recommended in writing by manufacturer of primary materials.
- C. System Characteristics:
1. Color and Pattern: As selected by Architect from manufacturer's full range
 2. Wearing Surface: Textured for slip resistance.
 3. Overall System Thickness: 20 mils (0.5 mm)
- D. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested in accordance with test methods indicated:
1. Compressive Strength: minimum in accordance with ASTM C579.
 2. Tensile Strength: minimum in accordance with ASTM C307.
 3. Flexural Modulus of Elasticity: minimum in accordance with ASTM C580.
 4. Water Absorption: percent maximum in accordance with ASTM C413.
 5. Shrinkage: percent maximum in accordance with ASTM C531.
 6. Indentation: percent maximum in accordance with MIL-D-3134J.
 7. Impact Resistance: No chipping, cracking, or delamination and not more than 1/16-inch (1.6-mm) permanent indentation in accordance with MIL-D-3134J.
 8. Resistance to Elevated Temperature: No slip or flow of more than 1/16 inch (1.6 mm) in accordance with MIL-D-3134J.
 9. Abrasion Resistance: maximum weight loss in accordance with ASTM D4060.
 10. Hardness: Shore D in accordance with ASTM D2240.
 11. Critical Radiant Flux: [0.45 W/sq. cm] [0.22 W/sq. cm] or greater in accordance with NFPA 253.
- E. System Chemical Resistance: Test specimens of cured resinous flooring system are unaffected when tested in accordance with ASTM D1308 for 50 percent immersion ASTM D543, Procedure A, for immersion, ASTM C267 for immersion in the following reagents for no fewer than seven days:
- F. Primer: Type recommended in writing by resinous flooring manufacturer for substrate and resinous flooring system indicated.
- G. Waterproofing Membrane: Type recommended in writing by resinous flooring manufacturer for substrate and resinous flooring system indicated.
- H. Patching and Fill Material: Resinous product of or approved by resinous flooring manufacturer and recommended in writing by manufacturer for installation indicated.

2.3 ACCESSORIES

- A. Repair Materials for Existing Concrete Floors
1. Minor patching and Small Cracks: as recommended by flooring manufacturer.
 2. Major Patching and Large Cracks (1/4"): as recommended by flooring manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resinous flooring systems.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare and clean substrates in accordance with resinous flooring manufacturer's written instructions for substrate indicated to ensure adhesion.

- B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous flooring.
 - 1. Roughen concrete substrates as follows:
 - a. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
 - b. Comply with requirements in SSPC-SP 13/NACE No. 6, with a Concrete Surface Profile of 3 or greater in accordance with ICRI Technical Guideline No. 310.2R, unless manufacturer's written instructions are more stringent.
 - 2. Repair damaged and deteriorated concrete in accordance with resinous flooring manufacturer's written instructions.
 - 3. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft. (18.6 sq. m), and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
 - a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate required by manufacturer.
 - b. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum percent relative humidity level measurement as required by manufacturer.
 - 4. Alkalinity and Adhesion Testing: Perform tests recommended in writing by resinous flooring manufacturer. Proceed with installation only after substrate alkalinity is not less than 6 or more than 8 pH unless otherwise recommended in writing by flooring manufacturer.
- C. Patching and Filling: Use patching and fill material to fill holes and depressions in substrates in accordance with manufacturer's written instructions.
 - 1. Control Joint Treatment: Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring in accordance with manufacturer's written instructions.
- D. Resinous Materials: Mix components and prepare materials in accordance with resinous flooring manufacturer's written instructions.

3.3 INSTALLATION

- A. Apply components of resinous flooring system in accordance with manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness specified.
 - 1. Coordinate installation of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.
 - 2. Cure resinous flooring components in accordance with manufacturer's written instructions. Prevent contamination during installation and curing processes.
 - 3. Expansion and Isolation Joint Treatment: At substrate expansion and isolation joints, comply with resinous flooring manufacturer's written instructions.
- B. Primer: Apply primer over prepared substrate at spreading rate recommended in writing by manufacturer.
- C. Reinforcing Membrane: Apply reinforcing membrane to substrate cracks.
- D. Integral Cove Base Accessories: Adhesively install precast accessories before applying flooring coats and in accordance with manufacturer's written instructions.
- E. Field-Formed Integral Cove Base: Apply cove base mix to wall surfaces before applying flooring coats. Apply in accordance with manufacturer's written instructions and details, including those for taping, mixing, priming, troweling, sanding, and topcoating of cove base. Round internal and external corners.
 - 1. Integral Cove Base: 4 inches (100 mm) high.
- F. Self-Leveling Body Coats: Apply self-leveling slurry body coats in thickness specified for flooring system.
 - 1. Aggregates: Broadcast aggregates at rate recommended in writing by manufacturer. After resin is cured, remove excess aggregates to provide surface texture indicated.
- G. Troweled or Screeded Body Coats: Apply troweled or screeded body coats in thickness specified for flooring system. Hand or power trowel and grout to fill voids. When body coats are cured, remove trowel marks and roughness using method recommended in writing by manufacturer.
- H. Grout Coat: Apply grout coat to fill voids in surface of final body coat.
- I. Topcoats: Apply topcoats in number indicated for flooring system specified, at spreading rates recommended in writing by manufacturer, and to produce wearing surface specified.

3.4 FIELD QUALITY CONTROL

- A. Material Sampling: Owner may, at any time and any number of times during resinous flooring installation, require material samples for testing for compliance with requirements.
 - 1. Owner will engage an independent testing agency to take samples of materials being used. Material samples will be taken, identified, sealed, and certified in presence of Contractor.

2. Testing agency will test samples for compliance with requirements, using applicable referenced testing procedures or, if not referenced, using testing procedures listed in manufacturer's product data.
 3. If test results show applied materials do not comply with specified requirements, pay for testing, remove noncomplying materials, prepare surfaces coated with unacceptable materials, and reinstall flooring materials to comply with requirements.
- B. Core Sampling: At Owner's direction and at locations designated by Owner, take one core sample per 1000 sq. ft. (92.9 sq. m) of resinous flooring, or portion of, to verify thickness. For each sample that fails to comply with requirements, take two additional samples. Repair damage caused by coring. Correct deficiencies in installed flooring as indicated by testing.

3.5 PROTECTION

- A. Protect resinous flooring from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by resinous flooring manufacturer.

END OF SECTION 096723

SECTION 096813 - TILE CARPETING

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 the Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Modular carpet tile.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For carpet tile installation, plans showing the following:
 - 1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
 - 2. Carpet tile type, color, and dye lot.
 - 3. Pattern of installation.
 - 4. Type, color, and location of edge, transition, and other accessory strips.
 - 5. Transition details to other flooring materials.
- C. Samples: For each exposed product and for each color and texture required.

1.4 INFORMATIONAL SUBMITTALS

- A. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.6 WARRANTY

- A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CARPET TILE MATERIALS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Interface
 - 2. Shaw Industries
 - 3. J&J Flooring Group
 - 4. Or approved equal.
 - a. Approved equals MUST be approved during bidding and be listed as approved in an addendum. It is the responsibility of the requestor to provide ample enough information (such as CSI Form 13.1A) to prove equality of requested "equal". If insufficient data is provided, substitution / approved equal request will be rejected.

2.2 CARPET TILE CPT-1, CPT-2

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Interface
 - 2. Or approved equal.
 - a. Approved equals MUST be approved during bidding and be listed as approved in an addendum. It is the responsibility of the requestor to provide ample enough information to prove equality of requested "equal". If insufficient data is provided, substitution / approved equal request will be rejected.
- B. Color: As indicated on the Drawings.
- C. Backing System:
 - 1. Basis of Design - CQuest Bio Backing (-C02)
- D. Size: As indicated on the Drawings .
- E. Applied Treatments:
 - 1. Soil-Resistance Treatment: Manufacturer's standard treatment.
 - 2. Antimicrobial Treatment: Manufacturer's standard treatment that protects carpet tiles as follows:

- a. Antimicrobial Activity: Not less than 2-mm halo of inhibition for gram-positive bacteria, not less than 1-mm halo of inhibition for gram-negative bacteria, and no fungal growth, according to AATCC 174.
- F. Metal Edge / Transition Strip: 6. Mechanically fastened, extruded aluminum with mill finish of profile and width shown, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.
 1. Basis of Design: Schluter Systems
 - a. Profile: Vinpro-U Reducer
 - b. Finish: To be selected by Architect
 2. ADA compliant
 3. Location: Use transition strip at transition from carpet to concrete

2.3 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.
- B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet tile, and are recommended by carpet tile manufacturer for releasable installation.
 1. Basis of Design – XL Adhesive 2000 Plus
 2. Flooring materials must meet testing and product requirements of Carpet and Rug Institute Green Label Plus Program Carpet Adhesive: SCAQMD Rule#1168.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Concrete Slabs:
 1. Moisture Testing: Perform tests so that each test area does not exceed sq. ft. (304.8 sq. m) and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
 - a. Relative Humidity Test: Using in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
 - b. Perform additional moisture tests recommended in writing by adhesive and carpet tile manufacturers. Proceed with installation only after substrates pass testing.
- B. Painted Subfloors: Perform bond test recommended in writing by adhesive manufacturer.

3.2 PREPARATION

- A. General: Comply with the Carpet and Rug Institute's CRI 104 and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile.
- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch (3 mm) wide or wider, and protrusions more than 1/32 inch (0.8 mm) unless more stringent requirements are required by manufacturer's written instructions.
- C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet tile manufacturers.
- D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

- A. General: Comply with the Carpet and Rug Institute's CRI 104, Section 10, "Carpet Tile," and with carpet tile manufacturer's written installation instructions.
- B. Installation Method: Glue down; install every tile with full-spread, releasable, pressure-sensitive adhesive
- C. Maintain dye-lot integrity. Do not mix dye lots in same area.
- D. Maintain pile-direction patterns indicated on Drawings.
- E. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.
- F. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, nonstaining marking device.
- H. Install pattern parallel to walls and borders.

- I. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 096813

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SECTION 099123 - INTERIOR PAINTING

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 surface preparation and the application of paint systems on interior substrates.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
 - 1. Include Printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
 - 2. Indicate VOC content.
- B. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.
 - 1. Submit Samples on rigid backing, 8 inches square.
 - 2. Apply coats on Samples in steps to show each coat required for system.
 - 3. Label each coat of each Sample.
 - 4. Label each Sample for location and application area.
- C. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Paint: 5 percent, but not less than 1 gal. of each material and color applied.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 - 1. Maintain containers in clean condition, free of foreign materials and residue.
 - 2. Remove rags and waste from storage areas daily.

1.6 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Sherwin Williams or comparable product by one of the following:
 - 1. Benjamin Moore & Co.
 - 2. PPG Architectural Finishes, Inc.

2.2 PAINT, GENERAL

- A. Material Compatibility:
 - 1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
- B. VOC Content: For field applications that are inside the weatherproofing system, paints and coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:
 - 1. Flat Paints and Coatings: 50 g/L.
 - 2. Nonflat Paints and Coatings: 50 g/L.
 - 3. Dry-Fog Coatings: 150 g/L.
 - 4. Primers, Sealers, and Undercoaters: 100 g/L.

5. Rust-Preventive Coatings: 100 g/L.
6. Zinc-Rich Industrial Maintenance Primers: 100 g/L.
7. Pretreatment Wash Primers: 420 g/L.
8. Shellacs, Clear: 730 g/L.
9. Shellacs, Pigmented: 550 g/L.
- C. Low-Emitting Materials: For field applications that are inside the weatherproofing system, 90 percent of paints and coatings shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- D. See paint schedule below for materials.
- E. Colors: As indicated on Material Legend on drawings.

2.3 SOURCE QUALITY CONTROL

- A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:
 1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
 2. Testing agency will perform tests for compliance with product requirements.
 3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Smoke Damaged areas: Thoroughly clean areas where smoke stains are present. Use neutral cleaner compliant with manufacturer's recommendation.
- C. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 1. Concrete: 12 percent.
 2. Gypsum Board: 12 percent.
- D. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- E. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- F. Proceed with coating application only after unsatisfactory conditions have been corrected.
 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.
- F. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturers.
 1. SSPC-SP 2.
 2. SSPC-SP 3.
 3. SSPC-SP 7/NACE No. 4.

- 4. SSPC-SP 11.
- G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 - 4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 - 5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
 - 1. Paint the following work where exposed in equipment rooms:
 - a. Equipment, including panelboards and switch gear.
 - b. Uninsulated metal piping.
 - c. Uninsulated plastic piping.
 - d. Pipe hangers and supports.
 - e. Metal conduit.
 - f. Plastic conduit.
 - g. Tanks that do not have factory-applied final finishes.
 - h. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
 - 2. Paint the following work where exposed in occupied spaces:
 - a. Equipment, including panelboards.
 - b. Uninsulated metal piping.
 - c. Uninsulated plastic piping.
 - d. Pipe hangers and supports.
 - e. Metal conduit.
 - f. Plastic conduit.
 - g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
 - h. Other items as directed by Architect-all exposed items in rooms with no ceilings.
 - 3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
 - 1. Contractor shall touch up and restore painted surfaces damaged by testing.
 - 2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINT SCHEDULE

- A. General:
 - 1. Refer to finish legend and finish schedule on drawings for more information on painted surfaces.
 - 2. See execution and surface prep for requirements at smoke damaged areas,
 - 3. **Shellac/Sealer:** Apply 1 coat of shellac/sealer at all smoke damaged walls and concrete structures prior to commencing primer and finish coats as outlined in paint schedule.
 - a. One coat pigmented shellac: Sherwin Williams White Pigmented Shellac Primer.
- B. **Dry Fall:** Concrete, Metals; exposed structure and overhead-mounted services including piping, ductwork, conduit etc. in spaces which do not receive a ceiling, are listed as OTS or have a partial or "floating ceiling" where spaces visible above are to be painted.
 - 1. Prime unpainted metals or touch-up primed metals with Sherwin Williams Pro Cryl Universal Primer
 - 2. Concrete and drywall do not require primers
 - 3. Two Coats: Sherwin-Williams Low VOC Waterborne Acrylic Dryfall.
- C. **Gypsum Board - Epoxy,** 3 coat Epoxy Semi-gloss typical walls at lab and prep spaces, toilets.
 - 1. One coat: Sherwin Williams Tuff Surface Acrylic Primer/Surfacer.
 - 2. Two coats: Pro Industrial Pre-catalyzed Epoxy, Semi-gloss
- D. **Gypsum Board - Latex, Flat:** soffits and ceilings only.
 - 1. One coat of Sherwin Williams Tuff Surface Acrylic Primer/Surfacer.
 - 2. Two coats ProMar 200 ZERO VOC Latex Flat
- E. **Gypsum Board - Latex, Semi-gloss,** 3 Coat: typical walls at mechanical, janitor, telecom/IT
 - 1. Two coats ProMar 200 ZERO VOC Latex Semi-Gloss
- F. **Gypsum Board - Latex, Eg-shel,** 3 Coat: typical walls at corridors and offices only.
 - 1. One coat of Sherwin Williams Tuff Surface Acrylic Primer/Surfacer.
 - 2. Two coats of Sherwin Williams Pro Industrial High Performance Acrylic Eg-shel.
- G. **Concrete/Masonry - Epoxy,** 3 Coat: Epoxy semi-gloss typical at lab and prep spaces
 - 1. One coat of block filler: SW PrepRite Blockfiller.
 - 2. Two coats: Pro Industrial Water Based Pre-catalyzed Epoxy, Semi-gloss.
- H. **Concrete/Masonry - Latex,** 3 Coat:
 - 1. One coat of block filler: SW PrepRite Blockfiller.
 - 2. Two coat of Sherwin Williams Pro industrial High performance acrylic Eg-shel.
- I. **Ferrous Metals, Pre-primed, Enamel,** 2 Coat: For shop primed substrates with acceptable primer.
 - 1. Touch-up with primer: Sherwin Williams Pro Cryl Universal Waterbased Primer.
 - 2. Two coats of Sherwin Williams Pro Industrial Water based Alkyd Urethane Enamel semi-gloss.
- J. **Galvanized Metals, Enamel,** 3 Coat:
 - 1. One coat of galvanize primer: Sherwin Williams Pro Cryl Universal Waterbased Primer.
 - 2. Two coats of Sherwin Williams Pro Industrial Water based Alkyd Urethane Enamel semi-gloss.

END OF SECTION 099123

SECTION 10 11 00 - VISUAL DISPLAY UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Visual display board assemblies.
 - 2. Support Systems for Visual display board assemblies.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, finishes, and accessories for visual display units.
- B. Shop Drawings: For visual display units.
 - 1. Include plans, elevations, sections, details, and attachment to other work.
 - 2. Show locations of panel joints.
 - 3. Show locations and layout of special-purpose graphics.
 - 4. Include sections of typical trim members.
- C. Samples: For each type of visual display unit indicated.
 - 1. Visual Display Panel: Not less than 8-1/2 by 11 inches (215 by 280 mm), with facing, core, and backing indicated for final Work. Include one panel for each type, color, and texture required.
- D. Product Schedule: For visual display units. Use same designations indicated on Drawings.

1.3 INFORMATIONAL SUBMITTALS

- A. Sample Warranties: For manufacturer's special warranties.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For visual display units to include in maintenance manuals.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver factory-fabricated visual display units completely assembled in one piece. If dimensions exceed maximum manufactured unit size, or if unit size is impracticable to ship in one piece, provide two or more pieces with joints in locations indicated on approved Shop Drawings.

1.6 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install visual display units until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings 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.

PART 2 - PRODUCTS

2.1 PRODUCT, GENERAL

- A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
 - 1. Deko Markerboards
 - 2. Clarus Glass Boards
 - 3. Or approved equal.
 - a. Approved equals MUST be approved during bidding and be listed as approved in an addendum. It is the responsibility of the requestor to provide ample enough information to prove equality of requested "equal". If insufficient data is provided, substitution / approved equal request will be rejected.

2.2 VISUAL DISPLAY BOARD ASSEMBLY MB-1

- A. Basis of Design: As indicated on the Drawings.
- B. Visual Display Board Assembly: Factory fabricated.
 - 1. Assembly: Markerboard.
 - 2. Corners: Square.
 - 3. Width: As indicated on Drawings.
 - 4. Height: As indicated on Drawings.
 - 5. Mounting Method: Z-Rail support system.
- C. Markerboard Panel: resinous markerboard panel on core indicated.
 - 1. Color: As Indicated in the Drawings
- D. Joints: Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, as indicated on approved Shop Drawings.

2.3 SUPPORT SYSTEM FOR VISUAL DISPLAY BOARD ASSEMBLIES

- A. Mounting: As indicated on the drawings.
 - 1. Support Rails: Horizontal, wall-mounted, extruded-aluminum rails designed to receive hanger clip and to support visual display boards.

- a. Finish: Manufacturer's standard.
 - B. Hanger Clips: Extruded aluminum with finish to match rails; designed to support independent visual display board assemblies by engaging support rail and top trim of board.
 - C. Visual Display Board Assemblies: Fabricated from not less than 3/8-inch- (9.5-mm-) thick, kraft-paper honeycomb core; designed to be rigid and to resist warpage, and with aluminum trim designed to engage hanger clips.
- 2.4 GENERAL FINISH REQUIREMENTS**
- A. Comply with NAAMM/NOMMA 500 for recommendations for applying and designating finishes.
 - B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 - C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. 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.
- 2.5 ALUMINUM FINISHES**
- A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
 - B. Color Anodic Finish: AAMA 611, AA-M12C22A32/A34, Class II, 0.010 mm or thicker.
 - C. Baked-Enamel or Powder-Coat Finish: AAMA 2603, except with a minimum dry film thickness of 1.5 mils (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance of the Work.
- B. Examine roughing-in for electrical power systems to verify actual locations of connections before installation of motorized, sliding visual display units.
- C. Examine walls and partitions for proper preparation and backing for visual display units.
- D. Examine walls and partitions for suitable framing depth where sliding visual display units will be installed.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions for surface preparation.
- B. Clean substrates of substances, such as dirt, mold, and mildew, that could impair the performance of and affect the smooth, finished surfaces of visual display boards.
- C. Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, projections, depressions, and substances that will impair bond between visual display units and wall surfaces.
- D. Prime wall surfaces indicated to receive visual display units as recommended in writing by primer/sealer manufacturer and visual display unit manufacturer.
- E. Prepare recesses for sliding visual display units as required by type and size of unit.

3.3 INSTALLATION

- A. General: Install visual display surfaces in locations and at mounting heights indicated on Drawings, or if not indicated, at heights indicated below. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.
- B. Factory-Fabricated Visual Display Board Assemblies: Attach concealed clips, hangers, and grounds to wall surfaces and to visual display board assemblies with fasteners at not more than 16 inches (400 mm) o.c. Secure tops and bottoms of boards to walls.
- C. Visual Display Board Assembly Mounting Heights: As indicated in the Drawings.
- D. Rail Support System: Install horizontal support rail at mounting heights indicated on Drawings, or if not indicated, at height indicated below. Attach to wall with fasteners at 12 inches (300 mm) o.c.

3.4 CLEANING AND PROTECTION

- A. Clean visual display units in accordance with manufacturer's written instructions. Attach one removable cleaning instructions label to visual display unit in each room.
- B. Touch up factory-applied finishes to restore damaged or soiled areas.
- C. Cover and protect visual display units after installation and cleaning.

END OF SECTION 101100

SECTION 101400 - SIGNAGE

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 SECTION INCLUDES

- A. Interior code required signs.
- B. Room identification signs.

1.3 RELATED REQUIREMENTS

- A. Division 21 through Division 26 for Signage and Identification Requirements.

1.4 REFERENCE STANDARDS

- A. 36 CFR 1191 - Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities; Final Rule; 2010; (ADA Standards for Accessible Design).
- B. ICC A117.1 - Accessible and Useable Buildings and Facilities.
- C. IBC - 2021 International Building Code

1.5 DESIGN INTENT DRAWINGS

- A. Design Drawings are intended to indicate the general type, location, and configuration of each sign included in the project. Bidders are responsible for reviewing existing conditions and preparing shop drawings to address specific conditions and construction for each sign type and location. Shop drawings are the sole responsibility of the fabricator in every respect.
- B. Fabricator/Installer represents and warrants that all Shop Drawings shall be prepared by persons and entities having expertise and experience in the signage industry. By submitting Shop Drawings, the Fabricator/Installer represents such Shop Drawings strictly comply with the requirements of the bid documents and that the Fabricator/Installer has determined and verified field measurements and field construction criteria related thereto, that materials are fit for their intended use and that the fabrication, shipping, handling, storage, assembly, and installation of all materials are in accordance with best practices in the industry. Fabricator/Installer shall be responsible for the correctness and accuracy of the dimensions, measurements, and other information contained in the Shop Drawings.
- C. Architect and/or Owner shall review the shop drawings only for conformance with general design intent. Fabricator/Installer shall not be relieved of responsibility for deviations from requirements of the Bid Documents by the Architect's approval of Shop Drawings, Product Data, Samples, or similar submittals. The Fabricator/Installer shall not be relieved of responsibility for errors or omissions in Shop Drawings, Product Data, Samples or similar submittals by the Architect's approval thereof.

1.6 SUBMITTALS

- A. 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.
- B. 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. Submit for approval prior to fabrication.
- C. 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. Samples, if approved may be incorporated into the finished work.
- D. Selection Samples: Where colors are not specified, submit two sets of color selection charts or chips.
- E. Verification Samples: Submit samples showing colors specified.
- F. Manufacturer's Installation Instructions: Include installation templates and attachment devices.
- G. Structure: All signs included are assumed to be suitable for installation directly to existing construction including but not limited to painted gypsum board, wood veneer and plastic laminate casework and doors, and interior glass windows and side lites. Installer shall be responsible for reviewing installation conditions including mounting surfaces and verifying suitability for installation without supplemental structure prior to submitting bids.

1.7 QUALITY ASSURANCE

- A. Quality of workmanship: The fabricator shall be responsible for the quality and delivery of all materials and workmanship required for the execution of the contract including the materials and workmanship of any firms or individuals who act as subfabricators with complete and up-to-date drawings, specifications, graphic schedule, and other information issued.
- B. Dimensions: Written dimensions on the drawings shall take precedence over scaled dimensions. Fabricator shall verify and be responsible for all dimensions and conditions noted in the drawings.
- C. Execution: Fabricator shall notify Architect/Owner of any discrepancies in the drawings or graphic schedule, in field dimensions or conditions, and/or changes required in construction details. Problems such as messages being too long to fit onto the required formats, difficulty in accurately reproducing logo or logo-type components, etc., must be brought to the attention of Architect/Owner prior to execution.
- D. Fabricator Recommendations: The fabricator shall review the provided drawings and propose recommendations and changes to improve the quality of any sign. Such recommendations and changes shall be approved in writing by Architect/Owner prior to preparation of shop drawings and/or fabrication of any signs.
- E. Labeling: There shall be no visible labels, manufacturer or otherwise, code permitting, on the completed signs. If labels are required, a sample label and intended location along with an explanation of the requirement must be submitted for Architect/Owner review, prior to application and/or installation.
- F. Materials: All materials, hardware, finishes, etc. used to fabricate all signs shall be new and free from any and all deformities and matched to the service conditions required of the site.
- G. Inspection: The fabricator shall examine the substrates and conditions under which the signs are to be installed and notify the owner's designated representative in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to all parties.
- H. Acceptance: All work shall be complete in every respect and satisfactory to all governing legislative authorities and building codes, Owner, and Architect.
- I. Warranty:
 - 1. Interior signage: manufacturer's standard one year warranty.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Package signs as required to prevent damage before installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Interior framed signs with custom inserts:
 - 1. Manufacturer's capable of replicating University of Missouri sign shop standards. Confirm with owner.
- B. Interior Panel Signs: Confirm materials and methods with University of Missouri sign shop.
 - 1. Extruded aluminum with clear anodized finish.
 - 2. Laminated, Etched Photopolymer: Raised graphics with Braille 1/32 inch (0.8 mm) above surface with contrasting colors in finishes and color combinations indicated and laminated to acrylic back.
 - 3. Edge Condition: Manufacturer's standard.
 - 4. Corner Condition: Manufacturer's standard.
 - 5. Mounting: Framed, as indicated.
 - a. Wall mounted with two-face tape and silicone adhesive.
 - b. Manufacturer's standard anchors for substrates encountered.
 - 6. Color: As selected by Architect.
 - 7. Tactile Characters: Characters and Grade 2 Braille raised 1/32 inch (0.8 mm) above surface with contrasting colors.

2.2 SIGNAGE APPLICATIONS

- A. Accessibility Compliance: All signs are required to comply with ADA Standards for Accessible Design and ANSI/ICC A 117.1 and applicable building codes, unless otherwise indicated; in the event of conflicting requirements, comply with the most comprehensive and specific requirements.

2.3 ACCESSORIES

- A. Concealed Screws: Stainless steel, galvanized steel, chrome plated, or other non-corroding metal.
- B. Sleeves: Cylindrical to cover attachment fasteners in same finish as sign.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that substrate surfaces are ready to receive work.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install neatly, with horizontal edges level.
- C. Contractor shall be responsible for determining the erection and dismantling of all barricade or protective coverings necessary to safeguard the public and property during the performance and duration of his work.
- D. Fabricator shall attach signs to substrates in accordance with and the manufacturer's instructions. Install level, plumb and at proper height. Repair or replace damaged units as directed by Architect/Owner. Visible abrasions to finished surfaces must be repaired as required to render damage invisible.
- E. Installation of all signage items shall be by the Fabricator. Installation includes provision of any anchor bolts, fastenings, attachment metals, and all other miscellaneous metal items imbedded in concrete or building wall material as required, and security of sign units in place with no visible fasteners unless noted otherwise.
- F. Signs installed on glass or other transparent surfaces shall be finished on all surfaces exposed to view, including surfaces visible through the glass. Adhesives or other forms of attachment exposed to view shall be invisible or match sign material color and finish. A finished backer panel on back side of glass will be acceptable.
- G. Trim inserts square to fit securely in frame without bubbling or wrinkling.

3.3 CLEANING AND PROTECTION

- A. Protect from damage until Substantial Completion; repair or replace damaged items.
- B. All items to be installed under the signage fabricator shall be left in a clean and orderly condition. Upon completion of the installation of each sign structure, clean all soiled sign surfaces in accordance with the manufacturer's instructions and touch up as required. Removal of protective masking shall be removed by the fabricator upon completion of installation. All existing furniture, equipment, etc. moved to facilitate installation shall be returned to its original configuration by installer after contract items are installed.
- C. Finish Surfaces: Sign units and inserts shall be warranted in writing by the fabricator for a period of no less than one year from the date of finished installation. There shall be:
 - 1. No delamination of any parts of the sign or of lettering from the sign face.
 - 2. No cupping, warping or dishing in excess of the requirements stipulated in the specifications.
 - 3. No bubbling, crazing, chalking, rusting, or other disintegration of the sign face, messages or edge finish of the panels.
 - 4. No movement of signs from their substrates. The signs must remain true and plumb on their substrate - except when the sign has sustained obvious post installation external damage.
 - 5. No fading of the colors when matched against a sample of the original color and material.
 - 6. No variation of any other performance specified on the drawing or in the specifications.

END OF SECTION

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SECTION 102113-TOILET COMPARTMENTS

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 toilet compartments configured as toilet enclosures, and urinal screens
- B. Related Sections:
 - 1. Section 061053 "Miscellaneous Rough Carpentry" for blocking.
 - 2. Section 102800 "Toilet, Bath, and Laundry Accessories" for toilet tissue dispensers, grab bars, purse shelves, and similar accessories.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For toilet compartments. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Show locations of cutouts for compartment-mounted toilet accessories.
 - 2. Show locations off reinforcements for compartment-mounted grab bars.
 - 3. Show locations of centerlines of toilet fixtures.
- C. Samples for Verification: For the following products, in manufacturer's standard sizes unless otherwise indicated:
 - 1. Each type of material, color, and finish required for units, prepared on 6-inch- 152-mm- square Samples of same thickness and material indicated for Work.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For toilet compartments to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Minimum 10 year experience manufacturing similar products.
- B. Installer Qualifications: Minimum 2 year experience installing similar products.
- C. Single Source Requirements: To the greatest extent possible provide products from a single manufacturer.
- D. Fire Resistance:
 - 1. National Fire Protection Association/International Building Code Interior Wall and Ceiling Finish: Class B.
 - 2. Flame Spread Index (ASTM E 84): 30 for panels and stiles.
 - 3. Smoke Developed Index (ASTM E 84): 55 for panels, 20 for stiles
- E. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities" and ICC/ANSI A117.1 for toilet compartments designated as accessible.

1.6 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of toilet fixtures, walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements before fabrication.
- B. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.

1.7 WARRANTY

- A. Manufacturer's Warranty (Sierra Series and DuraLine Series): Manufacturer's standard 25 year limited warranty for panels, doors, and stiles against breakage, corrosion, delamination, and defects in factory workmanship. Manufacturer's standard 1 year guarantee against defects in material and workmanship for stainless steel door hardware and mounting brackets.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Compact Laminate (Solid Phenolic) Toilet Partitions
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Bobrick Gap Free Privacy Style Duraline CGL or comparable product by one of the following manufacturers:
 - a. ASI Global Toilet Partitions

- b. ASI Accurate Toilet Partitions
 - C. Finished Thickness:
 - 1. Stiles and Doors: 3/4 inch (19 mm).
 - 2. Panels and Screens: 1/2 inch (13 mm).
 - D. Toilet-Enclosure Style:
 - 1. Mounting Configuration:
 - a. Floor-mounted, overhead-braced with satin finish, extruded anodized aluminum headrails, 0.065 inch (1.65 mm) thick with anti-grip profile and integral curtain tracks and hooks for compartments without doors.
 - b. Standard Height.
 - 1) Door/Panel Height: 58 inches (147 cm).
 - 2) Floor Clearance: 12 inches (30 cm).
 - 2. Privacy Style Partitions: No sightlines with gap-free interlocking doors and stiles routed 0.300 inches (7.6 mm) from the edge to allow for 0.175 inch (4.4 mm) overlap to prevent line-of-sight into the toilet compartment. Privacy strips fastened or adhered onto the partition material are not acceptable.
 - E. Urinal-Screen Style: Wall hung.
 - 1. Screen Height: 48 inches (107 cm) with 12 inches (46 cm) floor clearance. Top mounted at 60 inches above floor.
 - 2. Screen shall extend from the wall surface not less than 18 inches.
 - F. Stiles: Floor-anchored stiles furnished with expansion shields and threaded rods.
 - 1. Leveling Devices: 7 gauge, 3/16 inches (5 mm) thick, corrosion-resistant, chromate-treated, double zinc-plated steel angle leveling bar bolted to stile; furnished with 3/8 inch (10 mm) diameter threaded rods, hex nuts, lock washers, flat washers, spacer sleeves, expansion anchors, and shoe retainers.
 - 2. Stile Shoes: One-piece, 22 gauge (0.8 mm), 18-8, Type 304 stainless steel, 4 inch (102 mm) height; tops with 90 degree return to stile. One-piece shoe capable of adapting to 3/4 inch (19 mm) or 1 inch (25 mm) stile thickness and capable of being fastened (by clip) to stiles starting at wall line.
 - G. Wall Posts: Pre-drilled for door hardware, 18-8, Type 304, 16 gauge (1.6 mm) stainless steel with satin finish; 1 inch (25 mm) x 1-1/2 inches (38 mm) x 58 inches high (1473 mm).
 - H. Anchors: Expansion shields and threaded rods at floor connections as applicable.
 - I. Hardware:
 - 1. Compliance: Operating force of less than 5 lb (2.25 kg).
 - 2. Emergency Access: Hinges, latch allow door to be lifted over keeper from outside compartment on inswing doors.
 - 3. Materials: 18-8, Type 304, heavy-gauge stainless steel with satin finish.
 - 4. Doorstops: Prevents in swinging doors from swinging out beyond stile; on outswing doors, doorstop prevents door from swinging in beyond stile.
 - 5. Fastening: Hardware is secured to door and stile with pin-in-head Torx stainless steel machine screws. Hinges, latch and optional door stops secured to door with pin-in-head Torx stainless steel machine screws into factory-installed, threaded brass inserts. Fasteners for hinges, latch and optional door stops secured directly into core not acceptable.
 - a. Threaded Brass Inserts: Factory-installed; withstand direct pull force exceeding 1500 lb (680 kg) per insert.
 - 6. Coat Hooks: Projecting no more than 1-1/8 inch (29 mm) from face of door.
 - 7. Door Latch: Track of door latch prevents inswing doors from swinging out beyond stile; on outswing doors, door keeper prevents door from swinging in beyond stile; 16 gauge (1.6 mm) sliding door latch, 14 gauge (2 mm) keeper.
 - 8. Locking: Door locked from inside by sliding door latch into keeper.
 - 9. Hinge Type:
 - a. Full-Height Institutional Hinge.
 - 1) Hinges: 16 gauge (1.6 mm) stainless steel, self-closing, 3 section hinges.
 - 10. Mounting Brackets:
 - a. Full-Height.
 - 1) Mounting Brackets: 18 gauge (1.2 mm) stainless steel and extend full height of panel.
 - 2) U-Channels: Secure panels to stiles.
 - 3) Angle Brackets: Secure stiles-to-walls and panels to walls.
 - J. Materials: Solidly fused plastic laminate with matte-finish melamine surfaces; integrally bonded colored face sheets and black phenolic-resin core.
 - 1. Color of Plastic Laminate finish: As selected by Architect.
 - K. Edges: Black; brown edges not acceptable.
- 2.2 HARDWARE AND ACCESSORIES**
- A. Hardware and Accessories: Manufacturer's standard operating hardware and accessories.
 - 1. Material: Stainless steel where available, Chrome-plated brass elsewhere.

2. Hinges: Manufacturer's standard, cam type that swings to a closed or partially open position, allowing emergency access by lifting door.
 3. Latch and Keeper: Manufacturer's standard surface-mounted latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible.
 4. Coat Hook: Manufacturer's standard combination hook and rubber-tipped bumper, sized to prevent in-swinging door from hitting compartment-mounted accessories.
 5. Door Bumper: Manufacturer's standard rubber-tipped bumper at out-swinging doors.
 6. Door Pull: Manufacturer's standard unit at out-swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible.
- B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.
- C. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel, finished to match the items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless-steel steel anchors.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.
1. Units are to be privacy type with maximum Clearances complying with requirements of manufacturer for full privacy:
- B. Floor Anchored Units: Secure pilasters to supporting construction and level, plumb, and tighten. Hang doors and adjust so doors are level and aligned with panels when doors are in closed position.
- C. Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb, rigid, and secured to resist lateral impact.

3.2 ADJUSTING

- A. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges to comply with ADA requirements, otherwise, on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.
- B. Touch-up, repair or replace damaged products.
- C. Clean exposed surfaces of compartments, hardware, and fittings.

END OF SECTION

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SECTION 102600 - WALL PROTECTION

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. Stainless Steel corner guards and wall guards.
- B. Related Sections:
 - 1. Section 087100 "Door Hardware" for door edge protection, metal armor, kick and push plates.

1.3 ACTION SUBMITTALS

- A. Product Data: Include construction details, material descriptions, impact strength, dimensions of individual components and profiles for each impact-resistant wall protection unit.
- B. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each impact-resistant wall protection unit to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
- B. Source Limitations: Obtain impact-resistant wall protection units from single source from single manufacturer.
- C. Product Options: Drawings indicate size, profiles, and dimensional requirements of impact-resistant wall protection units and are based on the specific system indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store impact-resistant wall protection units in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Stainless-Steel Sheet: ASTM A 240/A 240M.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Floor Products Co., Inc.
 - b. Arden Architectural Specialties, Inc.
 - c. Balco, Inc.
 - d. Boston Retail Products.
 - e. Construction Specialties, Inc.
 - f. IPC Door and Wall Protection Systems; Division of InPro Corporation.
 - g. Korogard Wall Protection Systems; a division of RJF International Corporation.
 - h. Pawling Corporation.
 - i. Tepromark International, Inc.
 - j. WallGuard.com.
 - 2. Material: Stainless steel, Type 304.
 - a. Thickness: Minimum 0.0625 inch.
 - b. Finish: Directional satin, No. 4.

2.2 STAINLESS STEEL CORNER GUARDS - DRAWING DESIGNATION "CG"

- A. Surface-Mounted, Metal Corner Guards Fabricated from one-piece, formed or extruded metal with formed edges; with 90- or 135-degree turn to match wall condition.
 - 1. Wing Size: Nominal 2 inches each side.
 - 2. Height: 48 inches
 - 3. Corner Radius: 1/8 inch.
 - 4. Mounting: Double-faced foam tape Adhesive.

2.3 STAINLESS STEEL END-WALL GUARDS - DRAWING DESIGNATION "WG1"

- A. Surface-Mounted, Metal, End-Wall Guards Fabricated from one-piece, formed or extruded metal that covers entire end of wall; with formed edges.
 - 1. Wing Size: Nominal 2 inches each side.
 - 2. Height: 48 inches
 - 3. Corner Radius: 1/8 inch.
 - 4. Mounting: Double-faced foam tape Adhesive.

2.4 FABRICATION

- A. Assemble components in factory to greatest extent possible to minimize field assembly. Disassemble only as necessary for shipping and handling.
- B. Fabricate components with tight seams and joints with exposed edges rolled. Provide surfaces free of wrinkles, chips, dents, uneven coloration, and other imperfections. Fabricate members and fittings to produce flush, smooth, and rigid hairline joints.

2.5 METAL FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Remove tool and die marks and stretch lines, or blend into finish.
 - 2. Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - 3. Run grain of directional finishes with long dimension of each piece.
 - 4. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
- B. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine walls to which impact-resistant wall protection will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.
 - 1. For impact-resistant wall protection units attached with adhesive or foam tape, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Complete finishing operations, including painting, before installing impact-resistant wall protection system components.
- B. Before installation, clean substrate to remove dust, debris, and loose particles.

3.3 INSTALLATION

- A. General: Install impact-resistant wall protection units level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.
 - 1. Install impact-resistant wall protection units in locations and at mounting heights indicated on Drawings or, if not indicated, at heights indicated below:
 - a. 48 inches above base.
 - 2. Provide splices, mounting adhesives, hardware, anchors, and other accessories required for a complete installation.

3.4 CLEANING

- A. Remove excess adhesive using methods and materials recommended in writing by manufacturer.

END OF SECTION 102600

SECTION 10 28 00 - TOILET ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Bathroom accessories.
 - 2. Custodial accessories.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each finish specified, full size.
 - 1. Approved full-size Samples will be returned and may be used in the Work.
- C. Delegated-Design Submittal: For grab bars .
 - 1. Include structural design calculations indicating compliance with specified structural-performance requirements.

1.3 INFORMATIONAL SUBMITTALS

- A. Sample warranties.
- B. Product Certificates: Buy America Compliance Worksheet, as required by Project Contract Documents.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Design accessories and fasteners to comply with the following requirements:
 - 1. Grab Bars: Installed units are able to resist 250 lbf (1112 N) concentrated load applied in any direction and at any point.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Bobrick Washroom Equipment
 - 2. Bradley Corp.
 - 3. American Specialties, Inc
 - 4. Or approved equal.
 - a. Approved equals MUST be approved during bidding and be listed as approved in an addendum. It is the responsibility of the requestor to provide ample enough information (such as CSI Form 13.1A) to prove equality of requested "equal". If insufficient data is provided, substitution / approved equal request will be rejected.

2.3 PUBLIC-USE WASHROOM ACCESSORIES

- A. Toilet Tissue (Roll) Dispenser TD01:
 - 1. Basis of Design: Bobrick Washroom Equipment
 - a. B-4288 - Surface-Mounted Multi-Roll Toilet Tissue Dispenser
 - 2. Description: Double-roll dispenser.
 - 3. Mounting: Surface Mounted.
 - 4. Operation: Heavy duty, theft resistant.
 - 5. Capacity: Designed for up to 5 1/4" diameter tissue rolls.
 - 6. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin)
- B. Hand Dryers
 - 1. Owner Furnishes, Contractor Installed
 - 2. Dyson Airblade 9kJ
- C. Soap Dispenser SD01:
 - 1. Owner Furnished, Owner Installed
- D. Grab Bars:
 - 1. Basis of Design: Bobrick Washroom Equipment
 - a. B-5806 Straight Grab Bars
 - 2. Mounting: Flanges with concealed fasteners.
 - 3. Material and Color: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
 - a. Slip resistant surface
 - 4. Outside Diameter: 1-1/4 inches
 - 5. Configuration and Length: Provide full configuration and sizes as notated on the drawings.

- a. 36 inches long
 - b. 42 inches long
 - c. 18 inches long
- E. Sanitary-Napkin Disposal Unit SN01:
 - 1. Basis of Design: Bobrick Washroom Equipment
 - a. B-4353- Recessed Sanitary Napkin Disposal
 - 2. Mounting: Recessed
 - 3. Door or Cover: Self-closing, disposal-opening cover and hinged face panel.
 - 4. Receptacle: Removable.
 - 5. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin)
- F. Mirror Unit M01:
 - 1. Basis of Design: Bobrick Washroom Equipment
 - a. B-165 2436 – Mirror with stainless steel channel frame
 - 2. Shape: Rectangular
 - 3. Size: 24 inch by 36 inch
 - 4. Material and Finish: Stainless Steel, Satin Finish
 - 5. Hangers: Manufacturer's standard mounting kit
 - a. Provide spacers behind mirror as required to ensure that mirror is placed level and straight.
 - 6. Frame: Minimal, thin
- G. Hook H01:
 - 1. Basis of Design: Bobrick Washroom Equipment
 - a. B-6727– Coat Hook
 - 2. Description: Double-prong unit
 - 3. Mounting: Concealed, surface mounted.
 - 4. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin)

2.4 CUSTODIAL ACCESSORIES

- A. Custodial Mop and Broom Holder BH01:
 - 1. Basis of Design: Bobrick Washroom Equipment
 - a. B-239 x 34 – Shelf with Mop and Broom Holders and Hooks
 - 2. Description: Unit with shelf, hooks, and holders.
 - 3. Length: 34 inch
 - 4. Hooks: Four
 - 5. Mop/Broom Holders: Three, spring-loaded, rubber hat, cam type.
 - 6. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
 - a. Shelf: Not less than nominal 0.05-inch- (1.3-mm-) thick stainless steel.

2.5 FABRICATION

- A. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
 - 1. Remove temporary labels and protective coatings.
- B. Grab Bars: Install to comply with specified structural-performance requirements.
- C. Contractor to provide reinforcement and blocking as necessary for all accessories.
 - 1. Adjustable Height Adult Changing Station – provide structural support and plywood backing as required to support requirements of adjustable table. Coordinate with manufacturer's written instructions.

END OF SECTION 10 28 00

SECTION 104413 - FIRE PROTECTION CABINETS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Fire-protection cabinets for portable fire extinguishers.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For fire-protection cabinets.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.4 COORDINATION

- A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
- B. Coordinate sizes and locations of fire-protection cabinets with wall depths.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements in ASTM E814 for fire-resistance rating of walls where they are installed.

2.2 FIRE-PROTECTION CABINET

- A. Cabinet Type: Suitable for fire extinguisher.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Guardian Fire Equipment, Inc.
 - b. JL Industries, Inc.; a division of the Activar Construction Products Group.
 - c. Larsens Manufacturing Company.
- B. Cabinet Construction: Nonrated.
- C. Cabinet Material: Aluminum sheet
- D. Semirecessed Cabinet: One-piece combination trim and perimeter door frame overlapping surrounding wall surface, with exposed trim face and wall return at outer edge (backbend).
 - 1. Square-Edge Trim: 1-1/4- to 1-1/2-inch (32- to 38-mm) backbend depth.
- E. Cabinet Trim Material: Aluminum sheet
- F. Door Material: Aluminum sheet
- G. Door Style: Solid opaque panel with frame
- H. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
- I. Accessories:
 - 1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
 - 2. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated.
 - a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER"
 - 1) Location: Applied to cabinet door.
 - 2) Application Process: Silk-screened.
 - 3) Lettering Color: Black.
 - 4) Orientation: Vertical.
- J. Materials:
 - 1. Aluminum: ASTM B221 (ASTM B221M) for extruded shapes and aluminum sheet, with strength and durability characteristics of not less than Alloy 6063-T5 for aluminum sheet.
 - a. Finish: Clear Anodized

2.3 FABRICATION

- A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Prepare recesses for semirecessed fire-protection cabinets as required by type and size of cabinet and trim style.
- B. Install fire-protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.
- C. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.
- D. Identification: Apply lettering at locations indicated.
- E. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

END OF SECTION 104413

SECTION 104416 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes portable, hand-carried fire extinguishers.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.5 COORDINATION

- A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet indicated.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Guardian Fire Equipment, Inc.
 - b. JL Industries, Inc.; a division of the Activar Construction Products Group.
 - c. Larsens Manufacturing Company.
 - 2. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.
- B. Multipurpose Dry-Chemical Type UL-rated 4A: 80B:C nominal capacity, with monoammonium phosphate-based dry chemical in manufacturer's standard enameled container.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Examine fire extinguishers for proper charging and tagging.
 - 1. Remove and replace damaged, defective, or undercharged fire extinguishers.
- B. Install fire extinguishers in locations indicated and in compliance with requirements of authorities having jurisdiction.

END OF SECTION 104416

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SECTION 115300 - LABORATORY EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A.	Section Includes:	Furnished By:	Installed By
	1. Laboratory Pure Water Systems	CM	CM
	2. Laboratory Ice Machine	CM	CM
	3. Gas Cylinder Restraints	CM	CM
B.	Related Sections		
	1. Division 22 Plumbing		
	2. Division 26 Electrical		

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Certificates and Product Test Reports: For each product
- C. Manufacturer's Standard warranty: For each product

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data: include in maintenance manuals.

PART 2 - PRODUCTS

2.1 Laboratory Pure Water Systems

- A. Pure Water System – Fisher Scientific
 - 1. Basis of Design: Millipore – Milli-Q Ultra Pure System, type 1 Ultra Pure Water from DI/RO feed water.
 - 2. Product #IQ7000, catalog #ZIQ7000T0
 - 3. Dispenser is catalog #ZIQPODOOO with a BioPak end of point filter.
 - 4. Contact Rep. Allison Sterchi <allison.sterchi@thermofisher.com

2.2 Laboratory Ice Machine

- A. Basis of Design Product: Scotsman UF424A-1
 - 1. Flaked Ice Machine

2.3 Gas Cylinder Restraints

- A. Basis of Design Product: JT Racking Systems 2 Deep Cylinder Rack
 - 1. 2D1W Racking System, 16" wide x 24" deep x 30" tall.
 - 2. Or similar products of similar dimensions and qualities, to be approved by architect and owner.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Verify that conditions of substrates previously installed under other sections or contracts are acceptable for product installation in accordance with manufacturer's instructions prior to installation.
 - 1. Proceed with installation only after unacceptable conditions have been remedied.

3.2 INSTALLATION

- A. For contractor furnished and/or installed items, coordinate installation with other trades. Verify utility services and rough in prior to delivery of product.

3.3 PROTECTION

- A. Protect installed product from damage during construction
- B. Repair damage to adjacent materials caused by installation.

END OF SECTION

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SECTION 115313 - LABORATORY CONTAINMENT DEVICES

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. Bench-top High-Performance Laboratory Fume Hoods (See Drawings and Schedule)
 - a. Service fixtures (i.e. water, gas, etc.) and electrical service fittings in Containment Devices
 - b. Piping and wiring within service fittings, light fixtures, switches, and other electrical devices in Containment Devices
 - c. ADAAG Fume hood base support.
 - d. Work Surfaces within fume hoods.
 - e. Cup sinks in fume hoods.
 - f. Ceiling enclosures for fume hoods.
 - 2. Class 2 type A2 Bio-Safety Cabinets
 - a. Service fixtures (i.e. water, gas, etc.) and electrical service fittings in Cabinet
 - b. Piping and wiring within service fittings, light fixtures, switches, and other electrical devices in Cabinet
 - c. Cabinet Base support.
 - d. Work Surfaces within Cabinet
 - 3. Horizontal Laminar Flow Clean Bench
 - a. Service fixtures (i.e. water, gas, etc.) and electrical service fittings in Enclosure
 - b. Piping and wiring within service fittings, light fixtures, switches, and other electrical devices in Enclosure
 - c. Enclosure Base support.
 - d. Work Surfaces within Enclosure

1.3 COORDINATION

- A. Coordinate layout and installation of framing and reinforcements for lateral support of containment devices
- B. Coordinate installation of containment devices with laboratory casework and other laboratory equipment.
- C. Coordinate utility service rough in with electrical and plumbing trades.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect finished surfaces during handling and installation with protective covering of polyethylene film or another suitable material.

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install containment devices until building is enclosed, wet work and utility roughing-in are complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Locate concealed framing, blocking, and reinforcements that support fume hoods by field measurements before being enclosed, and indicate measurements on Shop Drawings.

PART 2 PRODUCTS

2.1 PRODUCT REQUIREMENTS

- A. Fume Hoods
 - 1. Basis of design Product: Labconco 'Protector XL',
 - 2. Approved Manufacturers of Equal Product: Kewaunee Venturi
 - 3. Equals subject to approval of Architect and owner during bidding phase only
 - 4. Provide with ADAAG compliant base stand and fixtures where noted on drawings.
- B. Class 2, Type A2 Biosafety Cabinets
 - 1. Basis of Design Product: Labconco Purifier Logic+
 - 2. Approved Manufacturer of Equal Product:
 - a. Nuaire Labgard – NU-540
 - b. Baker Containment Enclosures
 - 3. Equals subject to approval of architect.
- C. Horizontal Flow Clean Bench:

1. Basis of Design Product: Labconco 'Purifier'
2. Approved Manufacturer of Equal Product:
 - a. Air Science Corp. 'Purair LF series'
 - b. Baker Containment Enclosures
3. Equals subject to approval of architect.

2.2 PERFORMANCE REQUIREMENTS – FUME HOODS

- A. Fume Hood Containment: Provide fume hoods that comply with testing according to ASHRAE 110.
 1. Average Face Velocity: 100 FPM plus or minus 10 percent with sashes fully open.
 2. Face-Velocity Variation: Not more than 15 percent of average face velocity across the face opening with sashes fully open.
 3. Sash Position: Fully open.
 4. Release Rate: 4.0 L/min
 5. Test Setup Modifications: Conduct tests with a minimum of three and a maximum of five people in the test room and with two 1-gal.3.8-L round paint cans, one 12-by-12-by-12-inch300-by-300-by-300-mm cardboard box, and three 6-by-6-by-12-inch150-by-150-by-300-mm cardboard boxes in the fume hood during the test. Position items from 6 to 10 inches150 to 250 mm behind the sash, randomly distributed, and supported off the work surface by 2-by-2-inch50-by-50-mm blocks.
 6. Walk-by Test: At the conclusion of containment test, execute three rapid walk-bys at 30-second intervals, 12 inches300 mm behind the mannequin. Test-gas concentration during each walk-by shall not exceed 0.1 ppm and shall return to specified containment value within 15 seconds.
- B. Static-Pressure Loss: Not more than 1/2-inch wg124 Pa at 80 FPM face velocity with sash fully open when measured at four locations 90 degrees apart around the exhaust duct and at least three duct diameters downstream from duct collar.
- C. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design fume hoods for seismic performance.
- D. Seismic Performance: Fume hoods, including attachments to other work, shall withstand the effects of earthquake motions determined according to ASCE/SEI 7
 1. Design earthquake spectral response acceleration, short period (Sds) for Project is as documented on the structural drawings.
 2. Component Importance Factor: 1.5.

2.3 PERFORMANCE REQUIREMENTS – BIOLOGICAL SAFETY CABINETS

- A. The bench-mounted Class II, Type A2 biosafety cabinets must conform to the following regulations and standards.
 1. NSF International – NSF/ANSI Standard 49 for Biohazard Cabinetry.
 2. Directive on the Restriction of the use of certain hazardous substances in electrical and electronic equipment (2002/95/EC) – RoHS Directive
- B. The bench-mounted Class II, Type A2 biosafety cabinet must carry the ETL listed mark for the following.
 1. UL 61010-1 (formerly 3101-1), Underwriters Laboratories Inc., Electrical Equipment for Laboratory Use.
- C. General Design Requirements (See Part 2 for details)
 1. Class II, Type A2 – suitable for testing and experimentation with low to moderate risk biological agents.
 2. Base Stands
 - a. Telescoping Stands – Support base adjustable for eight static height positions allowing the work surface height to be set between 30" (Seated Positions) and 37" (Standing Positions).
- D. Containment & Safety
 1. Cabinet shall provide biological containment protection for both operator and product proven by an actual test, (as conducted by NSF) and routinely validated by the manufacturer.
 2. Containment of biological hazards is achieved through a combination of HEPA filtration and directional, controlled airflow.
- E. Airflow
 1. Calculated Air Velocity: 100 to 110 fpm through 8" OR 10" sash opening with audible alarms which sound when safety glass sash window is not at its proper operating height.
 2. Measured Downflow Velocity: 50 to 60 fpm measured 4" above operating sash opening height. Must be true laminar (uniform) downflow as defined in NSF/ANSI Standard 49.
 3. Blower with Electronically Commutated Motor (ECM) shall be programmed to deliver a precise volume of air as required and automatically adjusts as filters load without relying on airflow sensors and protected from voltage (electrical) fluctuation. Systems using air (velocity or volume) sensors or pressure transducers to control blower speed are not acceptable.

4. The Cabinet shall provide an audio signal accompanied by digital display of alert or alarm status type specific to the alarm with diagnostic measures displayed on a line-of-sight (while seated) color display.
- F. HEPA Filters
 1. One supply and one exhaust HEPA filter. Each shall be a minimum of 99.99% efficient on all particles 0.3µm as scan-tested with DOP or equivalent.
 2. HEPA filters shall be industry-standard size.
 3. Motor-Blower shall be positioned so as to promote even filter loading, thereby prolonging the life of HEPA filters
 4. Motor-Blower shall automatically handle HEPA filter pressure equal to 200% of initial pressure without reducing total air delivery by more than 2%.
- G. Controls and Display
 1. Cabinet shall utilize a microprocessor control system.
 2. Accessible mounted controls for operation of:
 - b. Blower
 - c. Light
 - d. Electrical Outlets
 - e. UV Light
 - f. Timers
 - g. Alarm Mute (5 minute ring-back)
 - h. Menu navigation
 3. Easy to Use/Navigate Operating System performs the following Functions.
 - a. User Programmable and customizable biosafety cabinet operation (including blower, light, optional UV light, and timer functions) controllable by movement and position of the Safety Glass Sash.
 - b. User Programmable and customizable biosafety cabinet operation that idles the motor in a reduced flow mode, reducing energy consumption by over 80% while maintaining ISO Class 5 conditions.
 - c. Digital 12- or 24-hour clock.
 - d. HEPA filter life is displayed as a percentage using real time feedback from the ECM-blower's performance. HEPA filter life timers are not acceptable.
 - e. Complete diagnostic and troubleshooting functionality.
 - f. Security password protection of cabinet use.
 - g. Programmable timed operation of LED and germicidal ultraviolet (UV) light.
 - h. Password Protected Service menu for calibration and configuration of biosafety cabinet installation and operational parameters.
 - i. Selectable units of measure (Imperial or Metric).
 4. Alarms and Alerts – The cabinet shall provide both an audio signal and digital display that communicates and describes the alarm condition, provides corrective actions and utilizes a cross sectional diagram highlighting the potentially affected areas of the biosafety cabinet. Alarms shall exist for the following conditions:
 - a. Sash Height Alarm – indicating that the sash is higher than its nominal set point.
 - b. Airflow Alert – signifies that the automatically adjusting blower has had to make an abrupt change in order to maintain safe airflow.
 - c. Airflow Alarm – indicates that inflow or downflow velocities are excessively high or low.
 - d. System Error – Indicates a failure in the communication between the microprocessor controller and the ECM blower.
- H. Noise
 1. Sound level (as factory tested) shall be no more than 63 dBA measured 15 inches above the work surface and 12 inches in front of the safety glass sash, as stated by NSF/ANSI Standard 49.
- I. Illumination
 1. LED lighting shall provide 90 to 150 foot-candles on work surface per NSF/ANSI Standard 49. The ballast is to be electronic containing thermal protection with automatic reset.
 2. LED lighting shall be externally mounted from the work zone, energy efficient, and replaceable from front of the biosafety cabinet.
 3. Optional UV light shall be a 254 nanometer germicidal lamp with life timer and replacement notifications.
 4. The UV light shall be operable only when the sash is closed.
- J. Pass-Through and Bulkheads
 1. Sealed Service Pass-Through – All permanent and durable structures for the passing of electrical wires, cords and tubes are to be permanently sealed air-tight, and shall not allow for movement of the items passing through.
 2. Sealed Service Penetration – Penetrations will be air tight and sealed, and will provide for the addition of field installed service fixture/valves or testing equipment.

3. User-Modified Pass-Through – Cord, Tube & Cable Portals for the passing of such so to connect to instruments, one inside the biosafety cabinet, the other outside. Shall provide an airtight seal and be protected by a vacuum or negative pressure source.
4. All Pass-Through & Bulkhead types shall be tested and approved by NSF to the NSF/ANSI Standard 49.

K. Efficiency

1. Biosafety cabinets shall operate at, or lower than, the listed energy usage and heat output during normal operation:
 - a. 4' Models – 290 Watts / 990 BTU-HR
 - b. 6' Models – 490 Watts / 1672 BTU-HR
2. During periods of non-use, the cabinet's set-back mode should operate at an 85% reduction in energy consumption.

2.4 MATERIALS & FABRICATION – FUME HOODS

- A. Steel Sheet: Cold-rolled, commercial steel (CS) sheet, complying with ASTM A 1008/A 1008M; matte finish; suitable for exposed applications.
- B. Stainless Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304, stretcher-leveled standard of flatness.
 1. For perchloric acid fume hoods, use Type 316L instead of Type 304.
- C. Glass-Fiber-Reinforced Polyester: Polyester laminate with a chemical-resistant gel coat on exposed faces, and having a flame-spread index of 25 or less according to ASTM E 84.
- D. Polypropylene: Unreinforced polypropylene complying with ASTM D 4101, Group 01, Class 1, Grade 2.
- E. 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.
- F. Fasteners: Provide stainless steel fasteners where exposed to fumes.
- G. Provide Service fixtures and Sinks as indicated on the Drawings.
- H. General: Assemble fume hoods in factory to greatest extent possible. Disassemble fume hoods only as necessary for shipping and handling limitations. Fume hoods shall be capable of being partly disassembled as necessary to permit movement through a 35-by-79-inch889-by-2007-mm door opening.
- I. Ends: Fabricate with double-wall end panels without projecting corner posts or other obstructions to interfere with smooth, even airflow. Close area between double walls at front of fume hood and as needed to house sash counterbalance weights, utility lines, and remote-control valves.
- J. Splay top and sides of face opening to provide an aerodynamic shape to ensure smooth, even flow of air into fume hood.
- K. Hood Baffle
 1. Baffle system shall be designed to optimize the face velocity profile, and to capture a wide range of gaseous densities without adjustment or moving components.
 2. Shall provide a continuous horizontal slot at the work surface. Baffle panels shall have multiple horizontal slots, with a chamfered entry. Slot pattern shall be proven to optimize face velocity profile.
 3. The baffle system shall be constructed with the same material as the fume hood liner.
 4. The baffles shall be removable for cleaning. The primary baffles shall be three pieces to allow removal without the use of tools.
 5. Exposed components to be non-metallic. Metal components exposed to chemical environment are not acceptable.
 6. Moving parts or adjustment of any kind is not acceptable.
- L. Exhaust Connection
 1. 316 stainless steel with Chemical-Resistant Finish
 2. 12.81" ID to accommodate any 12" nominal duct without the need for a transition adapter. 3, 4, 5, and 6-foot hoods have one exhaust connection, 7 and 8-foot hoods have two exhaust connections. Additional components required to accommodate 12" nominal mechanical system are not acceptable.
 3. Ducting shall go inside the duct collar to ensure condensate travels into the hood and evaporates. Duct collars that allow duct connection over the collar are not acceptable.
- M. Airfoil
 1. Cold Rolled Steel with Chemical-Resistant Finish.
 2. Airfoil shall have an aerodynamic radius to sweep the air into the hood with minimal turbulence. Airfoil directs airflow across work top to remove heavier-than-air gases.
 3. Must allow the air to bypass underneath and through the foil and sweep across the work surface to prevent any back flow of fumes escaping from the front of the hood opening. This airflow continues even if blocked by the presence of the operator.
 4. Foil must extend back under the sash to prevent closure of the lower by-pass opening when the sash is in the fully closed position, directly on top of the airfoil.

- N. Sash Assembly
1. Glass: Fully tempered safety glass with unobstructed, side-to-side view of fume hood interior and service fixture connections.
 2. Dimensions: The full sash opening height is 28", the total unobstructed viewing height is 37.5" measured from the work surface.
 3. Sash Tracks: Steel with Chemical Resistant Finish. Shall include bump stops for opening and closing.
 4. Sash Handle: extruded aluminum with Chemical Resistant Finish. Sash handle includes a perforated air passage directly atop the handle to bleed air into the hood chamber and direct chemical fumes away from the user's breathing zone. The handle is ergonomic in design and is easy to grasp when operating
 5. Sash guides: Corrosion resistant extruded poly-vinyl chloride.
 6. Sash System
 - a. Vertical Sash (Cable and Pulley)
 - 1) Hoods have a single vertical sash counterbalanced by a single weight.
 - 2) Sash and weight to be connected via aircraft cable meeting MIL-W-83420 Military Specification.
 - 3) Rear pulleys shall be connected via timing shaft to prevent sash tilting and permit one finger operation at any point along full width sash handle. Maximum 7 pounds pull required to raise or lower sash throughout its full length of travel.
 - 4) Design system to hold sash at any position without creep and to prevent sash drop in the event of cable failure.
 - 5) Include a defeatable, and automatically resetting sash stop positioned for an 18" sash height.
- O. Electrical Components
1. Lighting
 - a. Provide UL Listed, high-efficiency, quick-start, T8 fluorescent lighting systems, including bulbs.
 - b. Vapor-Proof: all electrical components shall be outside of the contaminated air space. Lighting shall be located behind a laminated safety glass shield, sealed to the top of the hood liner.
 - c. The fluorescent light assemblies shall be serviceable from outside the fume hood cavity, without the use of tools.
 - d. Light switch to be included on the lower right corner post, at heights compliant with the Americans with Disabilities Act (ADA).
 2. Electrical Receptacles
 - a. The hoods shall be equipped with four (two per corner post) electrical receptacles :
 - 1) 115 volt, 60 Hz, three-wire polarized and grounded electrical duplex, with Ground Fault Circuit Interruption (GFCI)
 - b. Receptacles shall be individually wired to field wiring box, and each rated at 20 Amperes.
 - c. Cover plates shall be acid resistant thermoplastic.
 3. Wiring
 - a. Every electrical component shall be individually wired to a single point internal field wiring box (including individual duplexes/receptacles).
 - b. Field wiring box to be 7" x 4" x 2.5", grounded, and have (12) 7/8" diameter knock out penetrations.
 - c. Final wiring and circuit dedication is to be by others.
 - d. Each receptacle circuit shall accommodate being wired to a dedicated building circuit rated at 20A, or the receptacles ganged together on a building circuit with the total load not exceeding 20 Amperes.
 4. Fume hood to have third party validation of compliance to UL 1805 and UL 61010-1 by a Nationally Recognized Testing Laboratory (NRTL)
- P. By-Pass Opening
1. The size of the by-pass opening is controlled by sash position for use with a constant volume mechanical system. The hood shall not have a change in static pressure or exhaust volume across all sash positions.
- Q. Hood Safety Practices Label: Corrosion resistant plate attached to the left corner post of the fume hood with the following Hood Safety Practices:
1. For use with substances that produce hazardous levels of airborne chemicals: gas, fumes, vapors, dust
 2. Do not put your head in the hood.
 3. Minimize drafts and sudden movements in front of the hood.
 4. Work a minimum of six inches inside the hood.
 5. Elevate equipment above the work surface.
 6. Keep sill and baffle unobstructed.
 7. Do not use the hood for storage.
 8. Adjust the sash to smallest opening possible when in use.
 9. Close sash when unattended.

10. Do not remove any of the hood components.
 11. Do not place flammable solvents near heat, flame or sparks.
 12. Do not evaporate large amounts of flammable liquids.
 13. Wipe up spills immediately.
 14. Routinely validate airflow.
 15. If the ventilation system malfunctions, or airflow alarm indicates unsafe condition, close sash and discontinue hood operation immediately-call for help.
 16. Do not use with Biohazards or Perchloric Acid
- R. Fume Hood Accessories (Coordinate with Lab Casework Contractor)
1. Service Fixtures: Color-coded hose nozzle outlets and valves mounted inside the fume hood and controlled from the exterior with color-coded index handles
 - a. The hoods are equipped without service fixtures out of the factory, but service fixture kits must be supplied, per schedule / drawings.
 - b. Hose connectors located inside the fume hood cavity are chemically-resistant, glass-filled polypropylene with 6 serrations.
 - c. Service lines on kits shall be from valve to outlet
 - 1) Copper tubing unless otherwise noted
 - 2) Brass service lines for gas
 - 3) Stainless steel service lines for Deionized Water
 - 4) Connections shall be made with quick-connect compression fittings on the inlet and outlet of the valve body, soldered and brazed connections not easily disassembled are not acceptable.
 - 5) Inlet tubing not included
 - d. Valves
 - 1) Extruded brass valve and rotating seat, TFE-coated silicone bronze stem and TFE packing.
 - 2) Fixture handles are plastic and color coded as well as labeled for the designated type of service.
 - 3) Fixtures are rated at maximum pressure of 200 psi.
 - 4) Coefficient of flow for the valve, $C_v=0.43$.
 - 5) Valves kits are designed for front loaded installation, located on the fume hood corner post for remote use, and may include:
 - a) Cold tap water (flow rate 3.5 GPM or 13.25 LPM at 67 psi at full open
 - b) Air (theoretical flow rate of 59 CFM at 100psi)
 - c) Vacuum (theoretical flow rate of 6 CFM at 10 psi)
 2. Tissue Screen: Provide epoxy-coated, stainless-steel screen at bottom baffle opening to prevent paper from being drawn into the exhaust plenum behind baffles.
 3. Rear Finish Panel: Where rear of hood will be visible, provide finished rear panel
 4. Face Velocity Monitor/Alarm
 - a. Audio/Visual Airflow Monitor
 - 1) Provide audible and visual alarm in the event of an unsafe face velocity.
 - 2) Alarm must sit flush with the fume hood corner post.
 - 3) Based on a thermally compensated thermistor in the alarm module, and air passing through a separate airstream into the hood interior.
 - 4) LED lights display red for alarm and green for normal operation.
 - 5) Must include external alarm and night setback functions.
 - 6) Alarm mute shall be accessible from the front of the monitor; visual alarm must remain activated until alarm condition is corrected.
 - 7) UL Listed electrical components
 - 8) Calibration shall be through a front located potentiometer.
 - 9) Calibration is the responsibility of the owner, following a complete balancing of the mechanical system, and concurrently with As-Installed testing.
- S. Work Surface
1. To match project lab worksurface, LWS1 – reference material finish schedule
 2. One inch radius front edge for optimal High efficiency fume hood performance.
 3. 3/8" dished area to match the fume hood interior work space and form a water tight pan for spill containment.
 4. Include a 2.5" diameter hole on each side for service pass-through and piping. Hole to be covered by hood superstructure upon installation, providing solvent storage vent kit steel tubing access route to exhaust duct above hood
 5. Include two 1.5" diameter penetrations to accommodate acid storage cabinet venting. Holes to be located outside of dished area and under the fume hood baffles. Include plugs to cover unused vent holes.
 - a. Flexural Strength: Not less than 10,000 psi (70 MPa).

- b. Modulus of Elasticity: Not less than 2,000,000 psi (1400 MPa).
 - c. Hardness (Rockwell M): Not less than 100.
 - d. Water Absorption (24 Hours): Not more than 0.02 percent.
 - e. Heat Distortion Point: Not less than 260 deg F.
 - f. Flame-Spread Index: 25 or less per ASTM E 84.
6. Cupsink- Cupsink where noted on drawings and/or schedule
- T. Supporting Base Cabinets (Coordinate with Lab Casework Contractor for both procurement and installation)
- 1. Base cabinets shall be in depths of 22", widths, quantities, and types called out in the equipment schedule and / or drawings, and meet the requirements of this specification.
 - 2. Construction requirements for all cabinets
 - a. Exterior construction is 18 gauge (or heavier) cold rolled sheet steel with Chemical Resistant Finish.
 - b. Hinges are 10 gauge (or heavier) plate with self-clinching pilot pin. Knuckle, bullet, or piano type hinges are not accepted.
 - c. The rear panel will feature a 12" x 8" removable plumbing access panel.
 - d. Units 24" wide or less have only one door.
 - e. Each cabinet includes four leveling feet.
 - f. Capable of supporting up to 800 pounds.
 - g. A filler panel is required to increase the cabinet depth to work surface depth.
 - 3. Acid Storage
 - a. Overall exterior dimensions:
 - 6) 48" 48" w x 22" d x 35.5"-36.75"
 - 7) 36" 36" w x 22" d x 35.5"-36.75"
 - 8) 30" 30" w x 22" d x 35.5"-36.75"
 - 9) 24" 24" w x 22" d x 35.5"-36.75" h or 31.5"-32.75" for ADA cabinet
 - 10) 18" 18" w x 22" d x 35.5"-36.75" h or 31.5"-32.75" for ADA cabinet
 - b. Completely lined with a polyethylene corrosion resistant liner. The liner is 3/16" thick, with a vacuum formed PVC liner pan at the bottom to contain spills. Each door has a 3/16" sheet polyethylene liner.
 - c. The cabinet is labeled: "ACID".
 - d. Flush pull handles are ABS, low gloss black.
 - e. Each cabinet shall be vented into the fume hood with a 1-1/2" pvc vent kit. It should provide a positive airflow directly into the fume hood exhaust system.
 - f. Supply an epoxy coated steel shelf with PVC liner pan if indicated in the schedule.
 - g. Acid cabinets with louvers are not acceptable
 - 4. Solvent Storage
 - a. Overall exterior dimensions:
 - 1) 48" 48" w x 22" d x 35.5"-36.75"
 - 2) 36" 36" w x 22" d x 35.5"-36.75"
 - 3) 30" 30" w x 22" d x 35.5"-36.75"
 - 4) 24" 24" w x 22" d x 35.5"-36.75" h or 31.5"-32.75" for ADA cabinet
 - b. Solvent storage cabinets are specifically designed for the storage of flammable and combustible liquids.
 - c. Solvent Storage Cabinet and accessory stainless steel vent kit must be compliant with NFPA 30 "Flammability and Combustible Liquids Code"
 - d. Cabinets 30" wide and greater shall be tested and approved by Factory Mutual to meet Factory Mutual Approval Standard 6050.
 - e. The bottoms, top, sides, and doors are fabricated of 18 gauge steel and are all double panel construction with a 1-1/2" air space between panels.
 - f. All joints are welded or screwed to provide a rigid enclosure. A 2" deep liquid tight pan that covers the entire bottom of the cabinet shall be furnished to contain liquid leaks and spills.
 - g. A full-depth, 18 gauge steel, adjustable shelf is also provided. Shelves are sealed leak tight.
 - h. Two diametrically opposed flame arrestor vents with spark screens are provided in the back of the cabinet, as well as a grounding screw.
 - i. The cabinet has an interior finish same as the exterior.
 - j. The cabinet is labeled: "FLAMMABLE - KEEP FIRE AWAY".
 - k. The right hand door shall have a three point latching device.
- U. Door handles include a key lock. Solvent storage handles are locking lever handles with bright chrome finish.

2.5 MATERIALS & FABRICATION– BIOSAFETY CABINETS

- A. Biosafety Cabinet Interior
 - 1. Unitized single-frame construction of 16 gauge, 304 Stainless steel. Shall pass factory test for holding pressure of 2" w.g. per NSF/ANSI Standard 49.
 - 2. Cabinet assembly shall be constructed such that all positive pressure contaminated plenums are surrounded by negative pressure plenums.
 - 3. Drain trough beneath the work tray is equipped to accommodate a 3/8" ball-type drain valve.
 - 4. Optional service fixture (on models with fixture) shall be quarter-turn, ball valve.
 - i. Valve shall be constructed of chrome-plated brass (or other based on requirements of service/utility provided).
 - j. Location of fixtures shall be ADA compliant for wheel chair accessibility.
 - 5. Internal air balancing system shall be accessible from the outside of the biosafety cabinet, and adjustable with a standard hex-nut driver.
 - 6. The Work Surface shall be of single piece, stamped, construction with no welding, applied sealant or solder used to seal any surface. All internal radiuses are 1/2" or greater.
 - 7. A metallic diffuser screen shall promote true laminar air flow.
 - 8. The cabinet shall accommodate up to 4 service fixtures.
 - 9. The cabinet shall be double wall construction with negative pressure airflow from drain pan to top surrounding the back of work area.
- B. Biosafety Cabinet Exterior
 - 1. Exterior front panel shall slope approximately 10° and has no visibility-interfering protrusions.
 - 2. Cabinet is designed such that all major service operations can be performed from the front of the cabinet.
 - 3. HEPA filters are removable from the front of the cabinet.
 - 4. A steel diffuser shall be mounted on top of the biosafety cabinet to promote proper exhaust airflow and protect the Exhaust HEPA filter.
- C. Dimensions
 - 1. The biosafety cabinet shall be capable of transport through a 32" wide opening.
 - 2. Overall exterior dimensions are as follows: (excluding Base Support)
 - a. 4 foot nominal width: 54.3" w x 61.7" h x 31.2" d
 - b. 6 foot nominal width: 78.3" w x 61.7" h x 31.2" d
 - 3. Overall interior dimensions are as follows:
 - a. 4 foot nominal width: 48.5" w x 61.7" h x 25.6" d
 - b. 6 foot nominal width: 72.5" w x 61.7" h x 25.6" d
- D. Blower
 - 1. Blower assembly shall be direct drive powered by energy saving ECM motor type.
 - a. 4' models will utilize a 1/2 HP ECM.
 - b. 6' models will utilize a 3/4 HP ECM.
 - c. Motor mounting system shall consist of 16 Gauge, stamped steel legs with integral vibration isolation.
 - 2. Blower shall be optimally determined forward-curved fan for each model size/width to maximize both energy efficiency and filter loading capacity.
- E. Sash Assembly
 - 1. Sash shall be single pane, tempered safety glass and angled 10° from vertical and be of a sliding operation.
 - 2. Sash shall be capable of being closed when cabinet is not in operation.
 - 3. Sash shall fully open to a height of 21.7".
 - 4. Total sash height shall provide a viewing window that is no less than 27.0" tall.
 - 5. A sash position indicator shall identify to the user where the sash is to be open to its optimum operating level.
 - 6. Sash shall not require removal for routine filter or motor/blower service.
 - 7. Bottom edge of sash shall be frameless and ground to a smooth edge so as to not disrupt line of sight. Framed sashes are not acceptable.
 - 8. Sash will be interlocked to cabinet operation such that UV light will not operate when sash is open, and the biosafety cabinet will alarm (audio & visual) when the sash is opened beyond its nominal height when the blower is in operation.
 - 9. Provide guides capable of holding the sash in place regardless of position and cushion sash with bumpers when fully opened or closed.
 - 10. Maximum force required to operate sash shall not exceed 7 lbs.
- F. Airflow and Foils
 - 1. Bottom of sash opening (Air Inlet Grille) is an aerodynamic, radiused foil to ensure smooth, even flow of air into biosafety cabinet.

2. Air inlet grille will have perforations on the leading edge to draw air into the biosafety cabinet should the operator inadvertently block the grille area.
 3. Corner posts are designed to be aerodynamic to ensure smooth, even flow of air into the sides of the sash opening on the biosafety cabinet.
 4. A negative pressure channel shall exist at the top of the sash opening to prevent loss of containment at the top of the sash. Mechanical wipers at the top of the work area promote the creation of hazardous aerosols, and are not acceptable.
- G. Electrical
1. A 10 foot 3-wire cord and plug will be provided to connect to electrical supply.
 - a. 3' and 4' 115V models will be provided with an IEC 60320 connector and NEMA 5-15 plug.
 - b. 6' 115V models will be provided with an IEC 60320 connector and NEMA 5-20 plug.
 2. Two internal Electrical Outlet Duplexes will be standard, one mounted on each side wall. Outlets mounted on the rear wall of the work area are not ADA compliant, and are not acceptable.
 - a. Duplexes shall be mounted flush to the stainless steel side walls of the biosafety cabinet's interior for easy cleaning,
 - b. Duplexes will have a self-closing stainless steel splash cover with dampened (slowed action) operation for safe operator use. Splash covers shall close not be fully closed in less than 1 second. Undampened, spring-loaded doors are not acceptable.
 - c. Duplexes will be located in compliance with ADA for wheelchair accessibility.
 - d. 115V model receptacles are NEMA 5-15.
 3. All major electronic components (ballasts, starters, switches, circuit breakers) shall be housed in a removable module for service or testing and be accessible from the front.
 4. Wiring Harness shall be color coded and alphanumerically labeled for identification. Removable wire tags shall not be used.
 5. Biosafety Cabinet shall have two separate internal circuits with breaker protection. One for service of controls, lighting and blower motor; one for internal electrical outlets.
 6. Biosafety Cabinet shall have optional dry relay contacts for connection to building management system. Will communicate alarms or use for control of HVAC Mechanical System (remote blower, valves) devices.
- H. Decontamination
1. Cabinet shall be easily fumigated employing an established procedure such as that recommended by NSF/ANSI Standard 49.
 2. Cabinet shall be provided with a 1" nominal diameter corrugated tube supplying a vaporized sterilant (Vaporized Hydrogen Peroxide – VHP, or Chlorine Dioxide – CD) to the positive pressure contaminated plenum for maximizing decontamination efficiency. Tube shall have a bright orange safety cap and be accessible from the front of the cabinet.
 3. Liner assembly shall have an integral face flange for sealing the cabinet during decontamination and pressure test operations.
 4. The biosafety cabinet's controls will provide a program that cycles the motor blower for maximizing decontamination efficiency.
- I. HEPA filters and Plenums
1. The positive pressure, contaminated plenum shall be permanent in construction, telescoping steel and provide uniform HEPA filter loading. Flexible, consumable plasticized plenums are not acceptable.
 2. Supply HEPA filter shall be of full cabinet work zone width and depth, and be tilted with the angle of the biosafety cabinet's front so as to provide laminar airflow behind the sash.
 3. Supply HEPA filter shall be protected by a perforated metal diffuser covering the entire top of the work zone.
 4. Supply and Exhaust HEPA filters are secured in the upper cabinet assembly by clamps.
- J. Controls and Display
1. Control panel with easy-to-clean membrane touchpad for system operations (blower, lights, mute) and Operating System navigation are mounted on the front of the cabinet and shall be ADA compliant. Controls mounted above sash are not acceptable.
 2. The audible/visual alarm indicator and mute switch shall be ADA compliant.
 3. The mute function will silence audible alarms for 5 minutes before engaging a ring-back function.
 4. Display shall be mounted in a position where it is line-of-sight while seated at the cabinet and can be viewed without strain to the operator.
 5. Display shall be Digital LCD and communicate cabinet status, HEPA filter life, alarms and cabinet set up. Analog pressure gauges do not adequately provide user communication adequate to specific to cabinet function and are not acceptable.
- K. Pass-Through and Bulkheads
1. Service Fixture Provisions will be provided to accommodate up to four valve installations, shall be sealed to meet air tight pressure requirements, and shall be ADA Compliant.

2. Cord and Cable Portal shall ship with a solid closed cell neoprene plug and be user-modified as needed per application.
3. Cord and Cable Portals shall not require further space requirements than recommended by the manufacturer and NSF/ANSI Standard 49.
4. Cord and Cable Portal design shall be approved by NSF testing.
- L. Ergonomics – The biosafety cabinet shall be ergonomically designed for maximum user comfort and adjustability to meet the requirements of the American with Disabilities Act (ADA).
 1. Biosafety Cabinet installation with base stand shall be positioned to provide work surface heights between 30" and 37", and be in compliance with ADA.
 2. Safety Glass Sash Assembly shall be anti-racking and counterbalanced with a weight and pulley system allowing for effortless movement up and down with one hand. Sash shall open to 21.7". Spring-loaded sash counterbalances require greater force as the sash raises and exerts force against the user's arms, this design is not acceptable.
 3. Air Inlet Grille shall have a large (greater than 2") integrated curved armrest to provide comfort for user when in a resting position while maintaining containment performance. Hard and sharp angles and elevated add-on arm/elbow rests promote poor ergonomic posture and are not acceptable.
 4. Maximum visibility into cabinet work zone shall be at least 27" from front access airfoil to exterior light housing.
 5. The biosafety cabinets work surface shall have easy-lift knobs located on the front corners and be removable through the front opening. The stamped dish will have coved corners for easy cleaning.
 6. The biosafety cabinet shall have a 10° slope front.
 7. All controls (touchpad, service fixtures valves, electrical outlet duplexes, cord and cable portals) shall be in compliance with ADA.
 8. The digital display shall be positioned line-of-sight while seated at the biosafety cabinet and communicate cabinet status and programming in full intuitive sentences.
- M. Required Accessories
 1. Telescoping Base Stands – shall be adjustable at installation to provide work surface heights between 30" and 37" and come with leg levelers. – Shall be NSF Approved.
 - k. Powder coated steel square tubing construction.
 - l. Shall include a full width storage shelf.
 - m. Shall be capable of adding 5" casters.
 - n. Seismic restraints with anchor bolts for floor mount design.
 2. Ultraviolet (UV) lamp – germicidal 254 nm wavelength lamp – Shall be NSF Approved.
 3. IV Bar with stainless steel hooks – shall be NSF Approved.
 4. Mass Airflow Monitor with integration into operating system that provides digital display of airflow readings and audible/visual alarms should readings be excessively low or high.
 5. Aspirator (Pump) Systems – for safe removal and handling of hazardous fluids.
 6. Gross Particulate Pre Filters
 7. Consumable G4 Filter kits OR
 8. RS 232 Connection ports
 9. Work surface with designated area to control temperature for heat/cold sensitive tissues or cultures.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of fume hoods.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install containment devices according to manufacturer's written instructions. Install level, plumb, and true; shim as required, using concealed shims, and securely anchor to building and adjacent laboratory casework. Securely attach access panels but provide for easy removal and secure reattachment. Where fume hoods abut other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical.
- B. Comply with requirements in Metal Laboratory Casework installing fume hood base cabinets, work tops, and sinks.
- C. Comply with requirements for installing water and laboratory gas service fittings and electrical devices.
 1. Install fittings according to Shop Drawings, installation requirements in SEFA 2.3, and manufacturer's written instructions. Set bases and flanges of sink and work top-mounted fittings in sealant recommended by manufacturer of sink or work-top material. Securely anchor fittings to fume hoods unless otherwise indicated.

- D. NSF/ANSI Standard 49 requires that Chemical Fume Hoods & biosafety cabinets be field tested after installation and prior to use. Include in the scope of The Work:
 - 1. A qualified independent (3rd party) certifier shall certify biosafety cabinets in accordance with NSF/ANSI Standard 49, Annex F.
 - 2. A qualified independent certifier shall certify chemical fume hoods in compliance with ASHRAE 110.
 - 3. Make all corrections until containment device passes Field Certification.
 - 4. Retest all other ventilation equipment that failed to perform as specified.

3.3 ADJUSTING AND CLEANING

- A. Adjust moving parts for smooth, near silent, accurate sash operation with one hand. Adjust sashes for uniform contact of rubber bumpers. Verify that counterbalances operate without interference.
- B. Clean finished surfaces, including both sides of glass; touch up as required; and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.

END OF SECTION 115313

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SECTION 122116 - VERTICAL LOUVER BLINDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Vertical louver blinds, PVC vanes.
- B. Related Requirements:
 - 1. Section 061000 "Rough Carpentry" for wood blocking and grounds for mounting vertical louver blinds and accessories.

1.2 ACTION SUBMITTALS

- A. Product Data:
 - 1. Vertical louver blinds, PVC vanes.
- B. Product Data Submittals: For each product.
 - 1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Rated capacities, operating characteristics, and furnished accessories.
- C. Shop Drawings: For vertical louver blinds.
 - 1. Fabrication and installation details.
- D. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type and color of vertical louver blind.
 - 1. Include Samples of accessories involving color selection.
- E. Samples for Verification: Actual sample of finished product for each type and color of vertical louver blind.
 - 1. Size: Manufacturers' standard size.
- F. Product Schedule: For vertical louver blinds. Use same designations indicated on Drawings.

1.3 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For vertical louver blinds with PVC vanes that have been tested for compliance with NFPA 701 for tests performed by a qualified testing agency.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For vertical louver blinds.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Materials: Furnish extra materials from the same production run to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Vanes: Furnish quantity of full-size units equal to 5 percent of quantity installed for each type, size, texture, pattern, and finish indicated, but no fewer than two units.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver vertical louver blinds in factory packages, marked with manufacturer and product name, and location of installation using same designations indicated on Drawings.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not install vertical louver blinds until construction and wet-work and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at levels indicated for Project when occupied for its intended use.
- B. Field Measurements: Where vertical louver blinds are indicated to fit to other construction, verify dimensions o-f other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain vertical louver blinds from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Window Covering Safety Standard: Provide vertical louver blinds that comply with WCMA A100.1 and are listed and labeled as "Best for Kids" by a qualified testing agency.

2.3 VERTICAL LOUVER BLINDS, PVC VANES

- A. Manufacturers
 - 1. Levolor
 - 2. American Blinds
 - 3. South Seas
- B. Flame-Resistance Rating: Comply with NFPA 701; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- C. Vanes: Lead-free, UV-stabilized, integrally colored, opaque, permanently flexible, extruded PVC that will not crack or yellow; with not less than 3/8-inch (9.5-mm) overlap when vanes are rotated fully closed.
 - 1. Width: 3-1/2 inches (89 mm).
 - 2. Profile: Flat.
 - 3. Features: Wand operation
- D. Headrail: Channel, formed steel or extruded aluminum with long edges returned or rolled and ends capped. Headrail encloses control mechanisms including carrier-spacing mechanism that provides uniform vane spacing when blinds are traversed fully across headrail (closed).
- E. Carriers: Engineered plastic with gears to align and synchronize vane rotation and stems that allow vane removal and replacement. Lead carriers have self-lubricating wheels or elongated bearing surfaces; remaining carriers have self-lubricating wheels.
- F. Manual Cordless Operation:
 - 1. Traverse and Rotation Operator: Single wand operates both traverse and rotation.
 - a. Wand Length: 30 inches (762 mm).
 - b. Wand Finish: White.
 - 2. Control Location: As indicated on Drawings.
 - 3. Draw and Stack: As indicated on Drawings, one way stack.
- G. Valance: Manufacturer's standard with vane insert.
- H. Mounting Brackets: With spacers and shims required for blind placement and alignment indicated.
 - 1. Type: Overhead.
 - 2. Intermediate Support: Provide intermediate support brackets to produce support spacing recommended by vertical louver blind manufacturer for weight and size of blind.
- I. Colors, Textures, and Patterns:
 - 1. Vanes: As selected by Architect from manufacturer's full range.
 - 2. Components: Provide materials exposed to view matching or coordinating with vanes unless otherwise indicated.

2.4 FABRICATION OF VERTICAL LOUVER BLINDS

- A. Unit Sizes: Fabricate units in sizes to cover window and other openings as follows, measured at 74 deg F (23 deg C):
 - 1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which blind is installed less 1/4 inch (6 mm) per side or 1/2 inch (13 mm) total, plus or minus 1/8 inch (3.1 mm). Length equal to head-to-sill dimension of opening in which blind is installed less 1/4 inch (6 mm), plus or minus 1/8 inch (3.1 mm).
- B. Concealed Components: Noncorrodible or corrosion-resistant-coated materials.
 - 1. Rotation-and-Traverse Mechanisms: With permanently lubricated moving parts.
- C. Mounting Brackets: Designed for removal and reinstallation of blind without damaging blind and adjacent surfaces, for supporting blind components, and for bracket positions and blind mounting method indicated.
- D. Installation Fasteners: No fewer than two fasteners per bracket, fabricated from metal noncorrosive to brackets and adjoining construction; type designed for securing to supporting substrate; and supporting blinds and accessories under conditions of normal use.
- E. Color-Coated Finish: For metal components exposed to view unless anodized or plated finish is indicated. Apply manufacturer's standard baked finish complying with manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION OF VERTICAL LOUVER BLINDS

- A. Install vertical louver blinds level and plumb, aligned and centered on openings, and aligned with adjacent units in accordance with manufacturer's written instructions.
 - 1. Locate so exterior vane edges are not closer than 2 inches (51 mm) from interior faces of glass and not closer than 1-1/2 inches (38 mm) from interior faces of glazing frames through full operating ranges of blinds.
 - 2. Install mounting brackets to prevent deflection of headrails.
 - 3. Install with clearances that prevent interference with adjacent blinds, adjacent construction, and operating hardware of glazed openings, other window treatments, and similar building components and furnishings.

3.3 ADJUSTING

- A. Adjust vertical louver blinds to operate free of binding or malfunction through full operating ranges.

3.4 CLEANING AND PROTECTION

- A. Clean vertical louver blind surfaces after installation in accordance with manufacturer's written instructions.
- B. Provide final protection and maintain conditions in a manner acceptable to manufacturer and Installer that ensures that vertical louver blinds are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged vertical louver blinds that cannot be repaired in a manner approved by Architect before time of Substantial Completion.

END OF SECTION 122116

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SECTION 12 24 13 - ROLLER WINDOW SHADES

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. Manually operated roller shades with single rollers.
- B. Related Requirements:
 - 1. Section 061053 "Miscellaneous Rough Carpentry" for wood blocking and grounds for mounting roller shades and accessories.
 - 2. Section 079200 "Joint Sealants" for sealing the perimeters of installation accessories for light-blocking shades with a sealant.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.
- B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.
 - 1. Motor-Operated Shades: Include details of installation and diagrams for power, signal, and control wiring.
- C. Samples: For each exposed product and for each color and texture specified, 10 inches (250 mm) long.

1.4 INFORMATIONAL SUBMITTALS

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For roller shades to include in maintenance manuals.

1.6 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. Roller Shades: Full-size units equal to 5 percent of quantity installed for each size, color, and shadeband material indicated, but no fewer than two units.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain roller shades from single source from single manufacturer.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Mecho Shade System
 - 2. Hunter Douglas Blinds & Shades
 - 3. LEVOLOR, Inc
 - 4. Draper, Inc.
 - 5. Or approved equal.

- a. Approved equals MUST be approved during bidding and be listed as approved in an addendum. It is the responsibility of the requestor to provide ample enough information to prove equality of requested "equal". If insufficient data is provided, substitution / approved equal request will be rejected.

2.2 MANUALLY OPERATED SHADES WITH SINGLE ROLLERS

- A. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.
 1. Basis of Design: Mecho5
 2. Bead Chains: Manufacturer's standard.
 - a. Limit Stops: Provide upper and lower ball stops.
 - b. Chain-Retainer Type: Clip, jamb mount
 3. Spring Lift-Assist Mechanisms: Manufacturer's standard for balancing roller shade weight and for lifting heavy roller shades.
 - a. Provide for shadebands that weigh more than 10 lb (4.5 kg) or for shades as recommended by manufacturer, whichever criterion is more stringent.
- B. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
 1. Roller Drive-End Location: Right side of interior face of shade
 2. Direction of Shadeband Roll: Reverse, from front (interior face) of roller.
 3. Shadeband-to-Roller Attachment: Manufacturer's standard method.
- C. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
- D. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers into a multiband shade that is operated by one roller drive-end assembly.
- E. Shadebands:
 1. Shadeband Material: Light-filtering fabric, Blackout fabric
 2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
 - a. Type: Enclosed in sealed pocket of shadeband material.
 3. Color and Finish: As indicated in the Drawings
- F. Installation Accessories:
 1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
 - a. Shape: L-shaped.
 - b. Height: Manufacturer's standard height required to conceal roller and shadeband assembly when shade is fully open, but not more than 4 inches (102 mm).
 - c. Finish: Fabric Wrapped
 - 1) To match shade material.
 2. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure.
 - a. Height: Manufacturer's standard height required to enclose roller and shadeband assembly when shade is fully open, but not more than 4 inches (102 mm).
 3. Endcap Covers: To cover exposed endcaps.

2.3 SHADEBAND MATERIALS

- A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701.
- B. Light-Filtering Fabric: Woven fabric, stain and fade resistant.
 1. Source: Roller shade manufacturer
 2. Roll Width: To Coordinate with Existing
 3. Openness Factor: 3% or Blackout, as indicated on drawings.
 4. Color: As indicated on Drawings.

2.4 ROLLER SHADE FABRICATION

- A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.
- B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F (23 deg C):

1. Outside of Jamb Installation: Width and length as indicated, with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.
- C. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible, except as follows:
 1. Vertical Shades: Where width-to-length ratio of shadeband is equal to or greater than 1:4, provide battens and seams at uniform spacings along shadeband length to ensure shadeband tracking and alignment through its full range of movement without distortion of the material.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 ROLLER SHADE INSTALLATION

- A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.
 1. Opaque Shadebands: Located so shadeband is not closer than 2 inches (51 mm) to interior face of glass. Allow clearances for window operation hardware.
- B. Roller Shade Locations: At exterior windows, as indicated in the Drawings.

3.3 ADJUSTING

- A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.4 CLEANING AND PROTECTION

- A. Clean roller shade surfaces, after installation, according to manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller shades are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

END OF SECTION 12 24 13

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SECTION 123553 - LABORATORY CASEWORK, FURNITURE AND WORKSURFACES

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. Fixed & Mobile Pre-Manufactured Wood Laboratory Casework
 - 2. Adaptable Laboratory Workbenches / Laboratory Furniture Systems
 - 3. Metal Laboratory Tables
 - 4. Wood (Metal) Chemical Storage Cabinets
 - 5. Worksurfaces, Sinks & Pegboards
 - 6. Gas Fixtures, Electrical/Data Raceways & Ceiling Utility Panels
- B. Related Requirements:
 - 1. Section 115313 Laboratory Containment Devices
 - 2. Section 115300 Laboratory Equipment
 - 3. Section 079200 - Joint Sealants for sealants used between casework and adjacent walls and other materials.
 - 4. Section 092216 – Non-Structural Metal Framing for coordinating reinforcements in metal framed partitions for anchoring laboratory casework.
 - 5. Section 115300 - Laboratory Equipment for miscellaneous laboratory equipment.
 - 6. Section 115313 - Bypass Laboratory Hoods with Vertical Sash for chemical fume hoods.
 - 7. Division 20 Sections for installation of gas service fittings and trim provided by this SECTION.
 - 8. Division 22 Sections for installation of water fittings and trim provided by this Section.
 - 9. Division 22 Sections for Epoxy Resin Sinks
 - 10. Division 20 Sections for steam and process water system components.
 - 11. Division 22 Sections for emergency drench showers and eyewashes used in non-public mechanical and utility areas.
 - 12. Division 26 Sections for electrical components installed in or on casework systems including:
 - a. Multi-outlet power and data/communications raceways.
 - b. Standard power and data/communications boxes and devices.
 - c. Task lights for installation on laboratory casework.

1.3 REFERENCE STANDARDS

- A. ANSI Z97.1 - Safety Glazing Materials Used in Buildings, Safety Performance Specifications and Methods of Test; 2004.
- B. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2008.
- C. ASTM A 666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2003.
- D. ASTM A 1008/A 1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength, Low Alloy, and High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable; 2007a.
- E. ASTM C 1036 - Standard Specification for Flat Glass; 2006.
- F. ASTM C 1048 - Standard Specification for Heat-Treated Flat Glass-Kind HS, Kind FT Coated and Uncoated Glass; 2004.
- G. BHMA A156.9 - Cabinet Hardware; 2003.
- H. NFPA 30 - Flammable and Combustible Liquids Code; 2008.
- I. SEFA 1-2010 - Laboratory Fume Hoods.
- J. SEFA 2-2010 - Installation of Scientific Laboratory Furniture and Equipment.
- K. SEFA 3-2010 - Work Surfaces.
- L. SEFA 8-2014 - Laboratory Casework.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product specified.
- B. Shop Drawings: For metal laboratory casework. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Indicate locations of blocking and other supports required for installing casework.
 - 2. Indicate locations and types of service fittings, together with associated service supply connection required.

3. Include details of utility spaces showing supports for conduits and piping.
4. Show adjacent walls, doors, windows, other building components, and other laboratory equipment. Indicate clearances from above items.
5. Include coordinated dimensions for laboratory equipment, fume hoods and laboratory accessories specified in other Sections.
- C. Samples for Verification: 6-inch- (square samples for each type of finish, including top material.
- D. Qualification Data: For firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience.
- E. Product Test Reports: Based on tests performed by a qualified independent testing agency, indicate compliance of laboratory casework finishes and top with requirements specified for chemical and physical resistance.
- F. Coordinate shop drawings with other work involved.
- G. Documentation of SEFA 8 Compliance
- H. Manufacturer's Installation Instructions.
- I. Maintenance Data: Manufacturer's recommendations for care and cleaning.
- J. Keying Data for Inclusion in Consolidated Keying Schedule specified elsewhere.

1.5 QUALITY ASSURANCE

- A. All casework construction and performance characteristics shall be in full compliance with SEFA 8 standards
- B. The Lab Casework Manufacturer must be a recognized manufacturer in the laboratory furniture industry with a minimum of ten (10) years experience in the industry and have five years or more experience in manufacture of laboratory casework and equipment of similar product type specified.
- C. Manufacturers shall have an ISO-9001 Accreditation.
- D. Single source responsibility: Laboratory furniture system, casework, work surfaces, laboratory equipment, chemical fume hoods and accessories shall be manufactured or furnished by a single laboratory furniture supplier.
- E. Manufacturer's qualifications: Modern plant with proper tools, dies, fixtures and skilled workmen to produced high quality laboratory casework and equipment, and shall meet the following minimum requirements:
- F. The table system must have the UL 962 Certification applicable to all system components including the table structure, shelving, plumbing service fittings, electrical services and all required pre-piping and pre-wiring.
- G. Laboratory furniture systems shall not be UL Listed in a manner that restricts the re-configuration of services after initial installation. System shall be able to host components that are UL submitted, approved and listed. Products must bear the UL Mark and shall be identified to those products that were evaluated by UL and found to comply with UL's requirements.
- H. All Lab Casework Manufacturers must obtain pre-qualification from the architect prior to bid based on Section 1.05. In addition, the Contractor will be required to supply the following:
 - I. Mock-up (see below)
 - J. Complete product catalog
 - K. ISO- 9001-2000 Certificate
 - L. UL962 Certificate
 - M. Sample of Warranty Document (see 1.13 below)

1.6 MOCK-UP

- A. Mock Up: Provide mock-up of one open laboratory bay complete with:
- B. Double-sided adaptable laboratory island workbench including connection to ceiling mounted serv ice panels and associated task lights.
- C. Six lineal feet of factory modular casework complete with countertops,
- D. At least two different configurations of mobile casework.
- E. Power, gases, data components and fixtures mounted in casework.
- F. Sealants.
- G. Approved mock-up may remain as part of the work.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Schedule delivery of laboratory furniture system so that spaces are sufficiently complete that material can be installed immediately following delivery. Coordinate temporary staging and project access with General Contractor
- B. Protect finished surfaces from soiling or damage during handling and installation.

1.8 FIELD CONDITIONS

- A. Do not deliver or install equipment until the following conditions have been met:

1. Windows and doors are installed and the building is secure and weather tight.
2. Ceiling, overhead ductwork and lighting are installed.
3. Ceiling grid installed prior to install of Ceiling Service Panels where applicable.
4. All painting is completed and floor tile is installed.

1.9 EXTRA MATERIALS

- A. Furnish to Owner complete touchup kit for each type and color of laboratory casework provided. Include fillers, primers, paints, and other materials necessary to perform permanent repairs to damaged casework finish.

PART 2 - METAL PRODUCTS

2.1 MANUFACTURERS

- A. Design, materials, construction and finish of laboratory casework and furniture specified is the minimum acceptable standard of quality for laboratory casework. The following manufacturers are approved.
1. Bedcolab
 2. Kewaunee;
 3. Mott Manufacturing LTD
 4. A.T. Villa USA, Inc.

2.2 WARRANTY

- A. Adaptable Laboratory Workbenches, Tables and Laboratory Furniture Systems
- B. The Lab Casework Manufacturer must certify in writing that all components of the laboratory furniture system included in this section are guaranteed for a period of three (3) years starting at the completion of the installation.
- C. The Warranty Document and a Maintenance Manual must be delivered to the owner within fifteen (15) days following the completion of the installation.
1. Fixed, & Mobile Pre-Manufactured Wood Laboratory Casework

2.3 METAL FINISH

- A. When fabrication of unit is completed but before applying finish all surfaces shall be checked and free of scratches, spot weld marks or material imperfections. Welds will be ground smooth where necessary.
- B. Preparation: Spray clean metal with a heated cleaner/phosphate solution, pre-treat with iron phosphate spray, water rinse, and neutral final seal. Immediately dry in heated ovens, gradually cooled to remove all traces of humidity.
- C. Application: Electrostatically apply urethane powder coat of selected color and bake in controlled high temperature oven for duration and at temperature recommended by the coatings manufacturer to assure a smooth, hard satin finish. Painted surfaces will conform to A.A.M.A. 2603. Liquid, dipped, solvent based finishes are not and will not be acceptable. Surfaces shall have a chemical resistant, high grade laboratory furniture quality finish of the following thickness:
1. Exterior and interior exposed surfaces:
 2. 1.5 mil average and 1.2 mil min.
 3. Backs of cabinets and other surfaces not exposed to view: 1.2 mil average.
- D. Cabinet Surface Finish Tests: All casework construction and performance characteristics shall be in full compliance with SEFA 8 standards for chemical, scratch, impact and heat resistance.
- E. Technical Performance:
- F. Adhesion to substrate: 100% 5B (ASTM D3359)
- G. Hardness: 3H (ASTM D3363)
- H. Gloss: 60 +/- 5 units on 60°
- I. Flexibility: ¼" Conical Mandrel (ASTM D522)
- J. Impact resistance: 100 in-lb direct: 100 in-lb reverse (ASTM D2794)
- K. Corrosion resistance: 1000 hrs. less 1/16" in creepage over B-1000 treated test panels (ASTM B117)
- L. Humidity resistances: 1000 hrs. no blistering over B-1000 treated test panels (ASTM D2247)
- M. Colors: At least 15 different colors across a spectrum of primary, natural and earth tone colors shall be available at no additional cost

2.4 Seismic Performance:

- A. Provide metal laboratory casework system capable of withstanding the effects of earthquake motions determined according to the building code in effect for this Project or ASCE 7, "Minimum Design Loads for Buildings and Other Structures," Section 9, "Earthquake Loads," whichever is more stringent.

2.5 DESIGN REQUIREMENTS

- A. Fixed Wood Laboratory Casework
1. QUALITY ASSURANCE

- a. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum ten years of documented experience.
 - 1) Company with at least one project in the past 5 years with value of woodwork within 20 percent of cost of woodwork for this Project.
 - 2) Accredited participant in the specified certification program prior to the commencement of fabrication and throughout the duration of the project.
 - b. Quality Certification:
 - 1) Provide labels or certificates indicating that the installed work complies with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade or grades specified.
 - 2) Provide designated labels on shop drawings as required by certification program.
 - 3) Provide designated labels on installed products as required by certification program.
 - 4) Submit certifications upon completion of installation that verifies this work is in compliance with specified requirements.
 - 5) Replace, repair, or rework all work for which certification is refused.
 - c. Quality Level – Perform work in accordance with AWI/AWMAC Architectural Woodwork Quality Standards Illustrated, Premium quality, unless other quality is indicated for specific items.
2. Certified Wood Materials: Provide cabinets made from wood and wood-based materials that are produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC 1.2, "Principles and Criteria."
 3. Adhesives: Do not use adhesives that contain urea formaldehyde.
 4. Solid Lumber Used: All hardwoods shall be carefully and thoroughly air-dried, and then kiln dried to a moisture content of 6-9 percent before use.
 5. Hardwood Plywood for Casework Body and Interior Shelving: All $\frac{3}{4}$ " plywood panels to be constructed as 7ply veneer core plywood. 1" panels shall be constructed as 9ply hardwood plywood panels. Panels to be produced from North American sources, import panels are not allowed.
 6. Hardwood Plywood for Door/Drawer heads to be manufactured using $\frac{3}{4}$ " 3 ply particle board Core, 3-Ply MDF Core or 7 Ply Combination Core plywood panels. Panel to be produced from North American sources, import panels are not allowed.
 7. Edgebanding for Wood-Veneered Construction: All banded edges (cabinet faces, frames, end panels, tops, bottoms and shelving) to be 3mm rolled hardwood or 5mm stick stock of the same species as the exposed veneer.
 8. Exposed Veneers
 - a. Provide Materials that are hand selected and arranged for compatible grain and color.
 - b. Wood Species and Veneer Cut: Plain sliced white maple, slipped matched.
 - c. Stain Colors and Finishes: Manufacturers standard selections
 - d. Solid Wood: Clear hardwood lumber
 - e. Hardwood Plywood Veneers: Grade AA exposed faces at least 1/45 inch thick, and grade 1 backs of same species as faces
 - f. Cabinet Design: Full Flush Overlay with 1/8" reveals between cabinet doors and drawers and 1/16" reveal at cabinet edge to maintain an 1/8" reveal between adjacent cabinet doors and drawers.
 - g. All Doors and Drawer Fronts will be vertically matched within the same cabinet.
 9. Semi-Exposed Plywood Veneers
 - a. Plywood Veneer faces used for semi-exposed area shall be constructed of the same species as the exposed veneer, Grade 1.
 10. Unexposed Veneers
 - a. Veneer of any species
 11. Base Units
 - a. Base cabinet top construction to be full stretcher frame consisting of a front top horizontal rail $\frac{3}{4}$ " x $3\frac{3}{4}$ " veneer core plywood, edge banding and fastened to cabinet ends with fluted dowels and a rear vertical support rails to be $\frac{3}{4}$ " x the drawer height plus 2" on cabinets with drawers and $\frac{3}{4}$ " x $3\frac{3}{4}$ " on all others. Rear bottom vertical support rail to be $\frac{3}{4}$ " x $3\frac{3}{4}$ " on all cabinets. All rear support rails to be fastened to cabinet ends with fluted dowels.
 - b. Intermediate rails shall match front rail materials and construction. Intermediate rails to be supplied where locks occur
 - c. Toe space rail shall be $\frac{3}{4}$ " x 3-3/4" and fastened to cabinet ends with fluted dowels to form a 3-3/4" high x 2" deep toe space
 - d. Cabinet bottoms shall be banded on the front exposed edge. It shall be set flush and fastened to cabinet ends with fluted dowels
 - e. Cabinet backs in semi-exposed cabinets shall be fabricated of one-piece $\frac{1}{4}$ " MDF core plywood, with matching cabinet veneer

- f. Cabinet backs on open cabinets will be one-piece $\frac{1}{4}$ " MDF core plywood, with matching cabinet veneer.
 - g. All base cabinet backs shall be removable without the need to remove the top drawer
 - h. Vertical dividers (full height and half height) shall be a minimum $\frac{3}{4}$ " material of matching species and grade as cabinet body. Dividers shall be secured to bottom, front top rail and rear top rail with dowels and screws. Exposed edges shall be edge banded matching cabinet body species
 - i. Adjustable shelves shall be adjustable at $1\frac{1}{4}$ " spacing. Front edges of shelves shall be edge banded. Shelves shall be full depth in standard cupboards and in open units. Adjustable shelves on base cabinets 36" and smaller shall be $\frac{3}{4}$ " thick. Adjustable shelves on cabinets over 36" wide shall be 1" thick. All shelving in open cabinets shall be 1" thick (regardless of cabinet size)
 - j. Drawer Construction: Drawer box back, front and sides to be of $\frac{1}{2}$ " Baltic Birch, 9 ply hardwood plywood and shall be finished with the same laboratory grade finish as applied to the cabinet. Use dovetail joinery on all four joints. Drawer bottom shall be $\frac{1}{2}$ " Baltic Birch, 9 ply hardwood plywood and shall be grooved into all four sides of the drawer box and glued into position. Drawer bottoms shall be finished using the same laboratory grade finish as applied to the cabinet. Drawer body will be affixed to drawer front by screws
12. Wall and Tall Units
- a. Case ends shall be $\frac{3}{4}$ " veneer core plywood edge banded on exposed edges
 - b. Case tops shall be 1" veneer core plywood edge banded on exposed edges and fastened to ends with fluted dowels.
 - c. Bottom of wall cases shall be 1" thick veneer core plywood, edge banded on exposed edge, set flush and fastened to cabinet ends with fluted dowels.
 - d. Bottom of tall cases shall be $\frac{3}{4}$ " thick and edge banded on exposed edges, fastened to cabinet with fluted dowels.
 - e. Backs of semi-exposed wall cabinets shall be $\frac{1}{4}$ " MDF plywood, with veneer matching that of the cabinet body. Back of semi-exposed tall cabinets shall be $\frac{1}{2}$ " plywood, with veneer and core matching that of the cabinet body. Backs will be captured on the ends and will be glued, screwed and stapled into the top and bottom. Rear rails will be applied to rear exterior of the cabinet
 - f. Fixed center shelves on tall cases shall be 1" thick with matching edge band on exposed edges on all open, hinged and sliding door cabinets. Fixed center shelves shall be fastened to ends with fluted dowels
 - g. Adjustable shelves shall be set on double pin, seismic plastic locking shelf supports at $1\frac{1}{4}$ " spacing. Front edges of shelves shall be edge banded. Shelves shall be full depth in standard cupboards and full depth in open units. Adjustable shelves on cabinets 36" and smaller shall be $\frac{3}{4}$ " thick. Adjustable shelves on cabinets over 36" wide shall be 1" thick. All shelving in open cabinets shall be 1" thick.
13. Framed Glazed Doors for Full flush overlay construction shall be fabricated of $\frac{3}{4}$ " x $2\frac{3}{4}$ " solid hardwood, using stile and rail construction
14. Mobile Base Cabinets: Refer to and coordinate with schedule on Drawings.
- a. Design requirements, performance requirements, materials, fabrication and hardware shall comply in all respects with fixed wood casework specifications as manufactured and cataloged.
 - b. Cabinets with casters shall be constructed without toe spaces. The cabinet shall be constructed with a reinforced base capable of supporting a 4" high caster assembly in each corner. Casters shall be swivel type and rated for minimum 250 pounds load each. Cabinets with casters and glides shall be completely finished on four sides since surfaces are considered visible. Top surface is consider concealed since it will be cover by countertop material.
 - c. Countertop: Top of mobile cabinet shall have a countertop as specified and shown in the drawings.
 - d. The entire cabinet assembly shall be reinforced to permit mobility without twisting and achieve an industry standard height of 31" or 37" including the flush 1 -inch countertop.
 - e. Base cabinets shall, except as noted, incorporate a flush overlay design in which the cabinet body is completely concealed.
 - f. Mobile cabinets with drawers shall be equipped with counterweights and an anti-tipping mechanism that includes an interlock so that only one drawer in a vertical stack can be opened at one time.
15. Wood Finish
- a. Casework shall be finished on all interior and exterior surfaces in a flat line, oven cured process, spraying a catalyzed vinyl coating specially formulated for laboratory casework and to be acid/solvent resistant (System 7 Catalyzed Vinyl).
 - b. Casework finish shall meet AWI Quality Standards Eighth Edition for Specialty Finishes – Premium Catalyzed Vinyl and SEFA 8 – 1999 Chemical Resistance Specifications. Manufacturers are to provide documentation to the architect of their finishes compliance to the above.

- c. Apply a coat of sealer and two finish coats to surfaces. Thoroughly sand surfaces between coats. Maximum film build is 6 wet mils and (2.9-3.3) mils dry.
 - d. Solids content to be minimum 35% by weight
 - e. Prior to finishing sand surfaces smooth, ensuring that they are free of dirt, defects, chatter and machine marks.
 - f. Apply sealer and finish coats to all exposed and semi exposed casework surfaces
 - g. Finish coat shall leave a smooth, clear, satin finish with consistent coloration.
 - h. Finishes must pass the following : 20 cycle Cold Check Test, Print Test ASTM D2091, Moisture Resistance Test, Impact Resistance Test, Hot Water Test, Chemical Resistance Test – ASTM D1308
16. Cabinet Hardware: Provide laboratory casework manufacturer's standard satin-finish, commercial-quality, heavy-duty hardware complying with requirements indicated for each type.
- a. Hinge: Stainless Steel, Institutional type 2 ¾", 5-knuckle.
 - b. Pulls: Stainless Steel 4" wire.
 - c. Drawer slides: Heavy Duty, Full Extension, Ball Bearing type equal to Accuride model #3832 full extension series. File drawer slides shall be equal to the Accuride model #4034, 150lb, full extension.
 - d. Locks: When indicated on drawings or called for, 5 disc tumbler cam locks with offset cam and removable core. Exposed face chrome plated. Keying: [Select - keyed alike or in groups per room with master key or keyed differently with security panels shall be 5 pin tumbler cam locks type with heavy duty interchangeable cylinder
 - e. Adjustable seismic shelf supports shall be double pin, plastic locking type, able to accommodate both ¾" and 1" thick shelves.
 - f. Door Catches: Adjustable type, spring activated nylon roller catches.
 - g. Label holders shall be formed steel 3 ½" x 1 ¾", overall size with satin chrome finish.
- B. ADAPTABLE LABORATORY WORKBENCHES / LABORATORY FURNITURE SYSTEMS
- 1. Reference Casework Diagrams on drawing sheets A800 for additional information.
 - 2. LOAD RATING - The adaptable workbench system shall be designed and tested to meet or exceed SEFA 8 Standards. The table shall also be tested to UL 962 Standards to 4 times the following claimed load capacity.
 - a. Work Surface: one hundred twenty-five (125) pounds per linear foot to a maximum of seven hundred fifty (750) pounds.
 - b. Shelves: forty (40) pounds per linear foot to a maximum total weight of four
 - 3. Provide movable casework assemblies capable of supporting an applied work surface load of 600 lbs. per module with a total applied load per module of 900 lbs. A module is the distance between uprights.
 - 4. Modular steel tube and weldment assembly structures with integrated and independent tabling systems allowing the addition of suspended base cabinets, overhead cabinets, mobile cabinets, shelving, electrical services, gas services, data services and common laboratory accessories.
 - 5. Frames: Tubular and steel weldment structures for tables, shelves and service chase for gas services, electrical and data cables.
 - 6. Modular units shall be suitable for wall, peninsula and island configurations.
 - 7. Framing system supported with tables system.
 - 8. Framing system must be adaptable to host gas services, electrical and data services. Services shall not be limited to initial installation configuration. Services must be interchangeable, and system should allow the user to remove or add services throughout the life of the product.
 - 9. Framing system shall not be UL listed in a manner that restricts the re-configuring of the system. Framing system should allow the use of UL Listed components, allowing the flexibility to change these services of the framing system.
 - 10. The table consists of 4-leg table that can be installed back-to-back and fixed together to become a double-sided assembly or as single-sided assemblies. The following options can be added to the system:
 - a. Top removable Distribution Center with integration of plumbing, electrical and data services.
 - b. Top removable Reagent Rack Distribution Center with integration of plumbing, electrical and data services.
 - c. Top Single Service Upright with integration of electrical services.
 - d. Top Single Service Upright with integration of electrical and data services.
 - e. Top Single Service Upright with integration of up to four plumbing services.
 - f. Free standing support that can hold either the Distribution center or the reagent rack distribution center.
 - g. Ceiling service panels

- h. Painted steel adjustable shelving
 - i. Integrated plumbing services with rigid pre-piping for up to four plumbing services inside each distribution center upright or the reagent rack distribution center with top connections to flexible hoses and quick disconnect fittings.
 - j. Electrical/data raceways and outlets installed inside the distribution center or the reagent rack distribution center pre-wired to the top of the unit with cords and plugs for connection to the Ceiling service panels.
 - k. Mobile, suspended or floor mounted cabinets under the tables.
11. Table Frames: Modular table system in configurations designed to attach to upright framing system, free standing and/or designed for perimeter installations.
12. Adjustable height tables using mechanical fasteners to secure system. System shall be installed initially at working heights indicated on the Drawings.
13. Levelers are included on framing system, attached tables, freestanding tables and perimeter tables.
14. System Requirements:
- a. The system shall consist of mechanically fastened components allowing for re-configuration. The system shall use uprights that use mechanically fastened supports for cabinets, shelves, services and accessories.
 - b. Structural components shall be self-supporting and independent of the building structure.
 - c. The framing system must support service fixtures, electrical and data modules and host supply lines in the uprights and top horizontal support structure.
 - d. The vertical height of table work surfaces and shelves shall be adjustable in 1" increments.
 - e. All services shall allow for the connection to the ceiling service panels directly and uninterrupted from the fixtures using quick connect devices. All gas services shall be interchangeable to allow field re-configurations of gas types and quantities.
 - f. All framing systems shall be gang-able and have ability to be attached to the building structure.
 - g. Table and framing system shall be designed to allow for full off-site assembly and be designed for a complete knock down assembly and disassembly allowing for onsite assembly, disassembly and complete re-configurations of the table and framing system.
 - h. Worksurfaces shall be Epoxy resin countertop (EP01) as indicated on the material finish schedule located on the drawings.
 - i. Provide lockable & leveling casters where casters are indicated on the drawings. Provide leveling glides where indicated on the drawings.
 - j. Provide upper shelving and cabinets where indicated on the drawings.
15. LOWER TABLE SECTION
- a. Under counter table is constructed of an 11-gauge channel structure welded to two 14-gauge - 2" diameter tube front legs with 1.3/4" inner 14-gauge telescoping bottom part for height adjustment. Both legs are equipped with a 3/8" by sixteen (16) NC by 3 1/2" leveler with non-marring floor glides.
 - b. The adjustable front legs are adjustable from 30" to 36" including the one (1) inch work surface and are capable of vertical adjustment in two (2) inch increments. Table is supplied with the proper front and back rails to support suspended cabinets. Two back legs 2" x 2 1/2" are mechanically attached to the structure to form a solid assembly.
 - c. Two table assemblies can be fixed together back-to-back to forms a complete double-sided assembly designed to fit the top distribution center or the reagent rack distribution center or the single service upright.
 - d. For anti-seismic requirements, a bolting device attached to the core structure levelers can be added to secure the table frame to the floor.
 - e. Work surface frames are designed to support optional Suspended Cabinets.
16. TOP REMOVABLE SERVICE DISTRIBUTION CENTER OPTIONS
- a. The 48" high structure top Distribution Center consists of two (2) uprights connected with an upper and a lower horizontal 14-gauge cross rail and channel to form a complete rigid unit that can be installed over single or double-sided tables. One upright houses the required pre-piped plumbing fixtures and data cables. The other upright integrates the electrical wiring of the raceways and the outlets located directly on the upright below the work surface. Both uprights offer full access to the interior with an easy removable full-height access panel. The uprights are slotted to fit adjustable shelving on both sides of the structure. The top distribution center is mechanically fixed into the base table back legs to form a solid assembly.

- b. The 18" high structure top Reagent Rack Distribution Center consists of two (2) uprights connected with an upper horizontal 14-gauge cross rail and channel to form a complete rigid unit that can be installed over single or double-sided tables. One upright houses the required pre-piped plumbing fixtures and data cables. The other upright integrates the electrical wiring of the raceways and the outlets located directly on the upright below the work surface. Both uprights offer full access to the interior with an easy removable full-height access panel. The uprights are slotted to fit adjustable shelving on both sides of the structure. The top distribution center is mechanically fixed into the base table back legs to form a solid assembly.
 - c. The 48" high top Single Service Upright can be installed over single or double-sided tables. The upright integrates the electrical wiring of the outlets located on the upright. It is supplied with an easy removable full-height access panel.
 - d. The Distribution Center uprights and the additional center upright for the sixty (60) inch, seventy-two (72) inch, eighty-four (84) inch and ninety-six (96) inch long tables are pre-punched to accommodate split shelving with one (1) inch long tables are pre-punched to accommodate split shelving with one (1) inch of upright.
 - e. The Reagent Rack Center uprights are pre-punched to accommodate one shelf on both sides of the structure.
 - f. A Single Service Upright cannot accommodate any shelving.
 - g. All uprights are fabricated from 11-gauge, cold-rolled steel, two (2) inch by five (5) inch exterior dimensions, oval formed tubing equipped with the required hardware to be mechanically fixed to the base tables.
17. PLUMBING FIXTURES In Adaptable Lab Furniture - General Requirements
- a. . One of the service uprights has the option to house up to four (4) plumbing services positioned between the work surface and the lower structural cross rail. Each service is clearly identified using color and mechanical coding.
 - b. Plumbing lines - Plumbing lines within the table shall be nine thirty-second inch (9/32") ID for both single and double outlets using stainless steel Type 316 tubing lines connected to valve fitting at worksurface or at upright with quick disconnect attached to the hose with compression fittings at location connecting ceiling service panel or other gas piping location.
 - c. No mechanical breaks shall occur in the hose line from the valve fitting to the quick connect fitting at the ceiling.
 - d. Each service connection is made between the uprights with a Staubli RBE keyed and double valve quick disconnect and the ceiling panel mounted RBE quick disconnect using a five sixteenths inch (5/16") ID flexible polyurethane coil hose.
 - e. The coil hose is equipped with a stainless steel RBE keyed quick disconnect fixture. The coil hose is available in white or colors to match the service color code. All RBE sockets and plugs are color and mechanically coded.
 - f. The RBE plugs of the coil hoses connect to the ceiling panel mounted RBE socket while the RBE socket of the coil hose connects to the RBE plug of the service upright.
 - g. Double valves on RBE plugs and sockets require no manual shutoff.
 - h. Internal construction of all fittings shall be stainless steel.
18. ELECTRICAL - DATA RACEWAYS
- a. A painted steel raceway is installed on the full width of the table core under the lower structural cross rail of the Distribution Center or the Reagent Rack Center.
 - b. Each raceway will have two (2) - 20 AMP hospital grade duplex receptacles per table side for tables in width varying from forty-two (42) inches, forty-eight (48) inches and sixty (60) inches. Three (3) 20-AMP hospital grade duplex receptacles per table side for tables of width varying from seventy-two (72) inches, eighty-four (84) inches and ninety-six (96) inches.
 - c. One (1) additional 20-AMP duplex receptacle is located in one of the back table leg under the work surface. This outlet shall be connected with one of the raceway outlets.
 - d. Each raceway can house up to a maximum of eight (8) - T6 data connections.
 - e. Wiring of the 20-AMP duplexes is in one upright with plumbing and data cables in the opposite upright support.
19. SERVICE CONNECTIONS in Adaptable lab Furniture - GENERAL REQUIREMENTS
- a. All services (plumbing, power, phone and data) make a direct and uninterrupted connection at the ceiling manifold system.
 - b. All services (plumbing, power, phone and data) shall be installed in a modular manner allowing the system to be altered at any time after installation.
 - c. All services (plumbing, power, phone and data) must be UL Listed components keeping the frame structure non UL Listed. Why do you want the frame structure non UL listed?

- d. Power services will have a 20 amp cord plug extending to the ceiling interface panels. Plug end to be twist lock on single frame and double sided (shared) frame.
- e. Or multi-circuit plugs for double sided tables with a maximum of three (3) circuits on the same plug.
- f. Data CAT6 line will have a male plug-in extending to the ceiling manifold system. (Connections to the facility to be provided by Div. 27.) **We recommend that devices, face plates and wiring be provided and installed by the data contractor.**
- 20. Leg structure support: 2.5" square tubing, 12 gauge hot rolled steel with 2.25" inner telescoping 12 gauge leg. Telescoping tubing shall be corner welded by high-frequency resistant welding and externally scarfed to agree with corner radii. Levelers are 3/8" - 16 NC x 2" long.
- 21. Leg and side aprons to be fully welded and not require side gussets for stability.
- 22. Front, back and side aprons: 3" x 1" cold rolled electric welded 14 gauge steel tubing. All welds seams of tubing to be oriented to the internal portion of the framing.
- 23. Rear work surface support:
 - a. Steel weldment of 14 gauge HRPO steel with height adjustability.
 - b. Minimum 8" high.
- 24. Shall be mechanically fastened between opposing rear legs to prevent frame racking.
- 25. Table frame structure shall allow the option to add cabinet stop feature for mobile cabinets.
- 26. Table frame structure shall provide the ability to mechanically suspend base cabinets from the table frame.
- 27. REAR FRAME SUPPORT STRUCTURE - ADAPTABLE LAB CASEWORK
 - a. General requirements for rear upright support frame structures:
 - b. System shall be available in single-sided and double-sided structures (shared frame assembly).
 - c. Frames shall be universal for maximum flexibility (not handed to one side or another).
 - d. Frames uprights shall allow for plumbing, electrical and data cabling.
 - e. All plumbing, electrical and data connections must be installed in a modular manner allowing onsite and post installation modifications to these services.
 - f. Frames shall not be UL Listed as to restrict re-configuration of services but shall utilize UL Listed components within the framing system.
 - g. System allows for knock down assembly and disassembly.
 - h. System allows for offsite assembly and transport to project facility fully assembled.
 - i. System must assemble with common tools and fasteners.
 - j. Framing system shall be designed to allow shelving, overhead cabinets and accessories to be mechanically fastened to the structure.
 - k. Nominal dimensions:
 - l. As indicated on the Drawings
 - m. Frame component details:
 - n. Single sided uprights shall be 12 gauge 2.5" O.D. square tubing.
 - o. Double sided (shared assembly) uprights shall be a 14 gauge HRPO steel weldment.
 - p. Levelers are 3/8" - 16 NC x 2" long with a 400 pound load rating per leveler (1 leveler per single upright and 2 levelers per double sided).
 - q. Uprights shall be able to carry gas services in a modular manner allowing for services to be removed, added or changed onsite during or after original installation.
 - r. Each upright must be able to carry a minimum of three gas lines.
 - s. Uprights shall be able to house a minimum of three electrical circuits (two above the worksurface and one below).
 - t. Uprights shall have holes machined on 1" increments for mechanical fastening of shelves, overhead cabinets and accessories starting at nominal 53" A.F.F. to within 2.5" of the top of the upright.
 - u. Framing system shall be able to host electrical and data with horizontal modules, allowing for re-configuration throughout the life of the product.
 - v. System shall be able to carry minimum of two circuits in horizontal modules.
 - w. All gas, electrical and data service shall be interchangeable in system post installation (any upright shall not be dedicated to one service permanently).
 - x. Horizontal cross supports to connect uprights shall be 11 gauge 2" x 1" steel tube weldment for single sided assemblies and 14 gauge formed steel weldment for double sided assemblies.
 - y. Attached table back panels shall be installed between upright framing to allow support for the rear of the worksurface and prevent side to side racking of the frame. Back panel shall be a 14 gauge HRPO steel weldment.
 - z. Gas services must provide a flexible gas lines running continuously from gas fixture in upright to the quick connect fitting at the ceiling without interruption of mechanical connections.
- 28. SHELVING

- a. Unless otherwise specified, all shelves are of double pan type, made of 18-gauge painted cold-rolled steel, and supplied with a welded two (2) inch high back rail that acts as a backstop.
- b. All bookend shelf supports are 14-gauge painted cold rolled steel.
- c. General requirements for shelves:
- d. All shelf supports shall be powder coated cold rolled steel.
- e. Shelf platforms shall be available in steel, phenolic resin or plastic laminate with 3mm wood edge banding.
- f. Shelves shall overhang 1" behind the face of the vertical tubular support.
- g. Shelf brackets: 14 cold rolled powder coated steel.
- h. Vertical shelf adjustment: one-inch increments.
- i. Load capacity: 200 pound uniform load per shelf
- j. Front support channel shall be 14 gauge cold rolled steel minimum.
- k. Rear support channel shall be 18 gauge cold rolled steel minimum.
- l. Shelves shall have integrated rear retaining lip
- m. bend 90 degrees into shelf platform on steel shelves.
- n. Rear retaining lip shall be integral in the shelf design.

C. LABORATORY TABLES

1. Reference Diagram on Sheet Q1.1.2 for additional information
2. Adjustable height tables using mechanical fasteners to secure system. System shall be installed initially at working heights indicated on the Drawings.
3. Levelers are included on freestanding tables.
4. Structural components shall be self-supporting and independent of the building structure.
5. The vertical height of table work surfaces shall be adjustable in 1" increments.
6. Table and framing system shall be designed to allow for full off-site assembly and be designed for a complete knock down assembly and disassembly allowing for onsite assembly, disassembly and complete re-configurations of the table and framing system.
7. At tables indicated to have pop up power outlets, install flip up table box meeting UL1363 standard, Duplex 20amp receptacles, and Duplex 3.1A USB receptacles. Box should be black with easy open and easy close operation. Basis of Design: 'Dequorum' Flip up table box. Provide 10' Cord and undertable cord management system.
8. Provide Epoxy Tops at all tables unless noted otherwise.

D. CHEMICAL STORAGE CABINETS

1. Flammable Liquid Storage: Provide units that are listed and labeled as complying with the requirements of NFPA 30 for design, construction, and capacity of storage cabinets by UL, Warnock Hersey, or another testing and inspection agency acceptable to authorities having jurisdiction.
 - a. Cabinets shall be grounded and vented.
 - b. Coordinate with Electrical Contractor grounding lug locations.
 - c. Flammable base cabinets shall be fitted with two (2) 2" round flanged metal supply and exhaust connections directed toward service chase for connection to building exhaust system. Freestanding flammable storage cabinets shall be fitted with 2" round flanged connections as detailed on drawings.
 - d. Cabinets shall have a minimum 2 inch deep liquid tight pan in bottom of same size as cabinet.
 - e. All OSHA cabinets shall be labeled in conspicuous lettering: "FLAMMABLE - KEEP FIRE AWAY".
 - f. Provide in White finish unless noted otherwise
2. Acid and Ventilated Storage-Cabinet Lining
 - a. Acid storage fume hood cabinets shall utilize the same gauges of steel and construction features as other base cabinets except they shall be completely lined with a one piece Polyethylene corrosion resistant liner. The liner shall be 1/4" thick, molded into a seamless tub, including top, sides and bottom, with a 1" lip at the bottom front to contain spills. Each door shall have a set of louvers at the top and bottom, and have a 1/8" sheet polyethylene liner. Where specified, each cabinet shall be vented into the fume hood with a 1-1/2" vent pipe. It should provide a positive airflow directly into the fume hood exhaust system. Where specified or shown on drawings, supply an epoxy coated wire shelf supported by integral brackets built into the Polyethylene liner.
 - b. Provide in white finish unless noted otherwise.

E. WORK SURFACES AND SPLASH GUARDS

1. General requirements for worksurface on Fixed Casework, Tables, and Adaptable Furniture.
2. Manufacturers:
 - a. Durcon

- b. American Epoxy Scientific or Approved Equal
- c. Finish:
 - 1) See material finish legend on drawings (provide comparable color to listed)
- 3. Worksurfaces Shall be supported on all front, rear and sides by table, Fixed Casework, or Adaptable Furniture assemblies to meet loading criteria detailed in the SEFA 8 standards.
- 4. Provide drip at front bottom of counter
- 5. Nominal dimensions:
 - a. As indicated on Drawings
- 6. Work surface Types
 - a. **Epoxy** resin - 1" thick
- 7. Side and Back Splashes:
 - a. Nominal dimensions:
 - b. Heights: 4" or as indicated on drawings
- 8. Side and Back Splashes Types -
 - a. **Epoxy** Resin -.75" thick
- 9. Countertop fabricator shall drill all holes and make all cuts in countertop materials as required for the proper installation of all plumbing and electrical work.

F. GAS FIXTURES & CEILING UTILITY PANELS

- 1. Ceiling Interface Panels
 - a. General requirements
 - b. Ceiling Interface Panel (CIP) (*often referred to as ceiling service panels or ceiling utility panels*) shall integrate within most standard-duty T-grid acoustical suspended ceiling systems.
 - c. CIP shall provide a means to mount and connect electrical outlets, data outlets and quick connect plumbing service fixtures.
 - d. The ceiling service panel shall integrate all required female connectors to fit the Adaptable Table System plumbing, electrical and data services.
 - e. Final connection to the ceiling service panels shall be the responsibility of the Mechanical subcontractors.
 - f. Gas services outlets shall be keyed quick-disconnect inlet plugs. Keyed quick disconnects shall be compatible with the specified gas service hose as specified.
 - g. Electrical devices shall be provided with a twist lock preventing plugs from becoming loose.
 - h. CIP shall accommodate single sided and back-to-back table configurations.
 - i. CIP will ship with junction boxes factory attached. Electrical outlets, data outlets, cover plates and service fixtures shall be ordered separately, and field installed. **Data wiring, cover plates and devices by data contractor.**
 - j. Construction Manager shall coordinate procurement and installation of all service fixtures within CIP's with appropriate sub-contractors. **Plumbing fixtures be supplied by the lab casework contractor.**
 - k. CIP shall be a minimum of 16 gauge cold rolled steel with a urethane powder coat finish.
 - l. Nominal Dimensions:
 - 1) Widths: 24" x 24"
 - 2) Height (including junction boxes): 3"
 - m. ACT grid installer shall provide additional wire support at all four corner locations of the CIP in the grid.
- 2. Laboratory Gas Fittings
 - a. Provide polished chrome on brass body, as manufactured by Watersaver or approved equal. Reference Drawings for fixture type and locations.
 - b. DI/RO fittings, Domestic Cold Water, and Hot Water specified in Plumbing Documents.

2.6 EPOXY RESIN SINKS:

- A. Integrally molded from modified thermosetting epoxy resin, specially compounded and oven cured and set with epoxy cement. Color shall match the adjacent countertop. Drop in units are acceptable. Physical properties shall be as described for epoxy resin countertops. Cove inside corners and pitch bottom to threaded drain outlet.
 - 1. Size: As scheduled.
 - 2. Location: All sinks shown in epoxy resin countertops.
 - 3. Drain location: Center.
 - 4. Tailpiece: Compatible with drain piping. Color to match sink.
 - 5. Color: Match adjacent epoxy resin countertops.
 - 6. Faucet ledge to be at rear of sink with deck mounted horizontal paddle arm style hand controls

7. located 4" to either side of faucet. Deck mounted eyewash units shall be located per manufacturer's recommendations.
8. Subject to compliance with these specifications, acceptable products include, but are not limited to, those manufactured and provided by the following companies. Use same manufacturer as laboratory worksurfaces.
 - a. - Laboratory Tops
 - b. - Durcon
 - c. - Epoxyn Products

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Furniture system installation:
 1. Install system in strict accordance with manufacturer's instructions.
 2. Set system components level on two planes with no distortion. Securely anchored to building structure using concealed shims where necessary in wall mount.

3.2 ADJUSTING

- A. Repair or remove and replace defective work, as directed by Architect & Owner upon completion of installation.

3.3 CLEANING

- A. Clean shop finished laboratory furniture system surfaces and touch up as required.

3.4 PROTECTION OF FINISHED WORK

- A. Provide all necessary protective measures to prevent exposure of laboratory furniture system and attached components from exposure to other construction activity.
- B. Advise contractor of procedures and precautions for protection of the installed laboratory furniture system and related components from damage by work of other trades.

END OF SECTION

SECTION 123661 – COUNTERTOPS

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. Solid-surface-material countertops, backsplashes and aprons
 - 2. Solid surface material windowsills.
- B. Related Requirements:
 - 1. Section 061053 "Miscellaneous Rough Carpentry" for countertop support brackets.
 - 2. Section 064116 "Plastic Laminate Faced Architectural Cabinets"
 - 3. Division 22 "Plumbing Fixtures" for sinks and plumbing fittings.

1.3 ACTION SUBMITTALS

- A. Product Data: For countertop materials.
- B. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.
 - 1. Show locations and details of joints.
 - 2. Show direction of directional pattern, if any
- C. Samples for Verification: For the following products:
 - 1. Countertop materials, 6 inches (150 mm) square. One of each type and color

1.4 FIELD CONDITIONS

- A. Field Measurements: Verify dimensions of countertops by field measurements after base cabinets are installed but before countertop fabrication is complete.

1.5 COORDINATION

- A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 - PRODUCTS

2.1 SOLID-SURFACE-MATERIAL COUNTERTOPS AND WINDOWSILLS SS-1

- A. Solid polymer components
 - 1. Cast, nonporous, filled polymer, not coated, laminated or of composite construction with through body colors meeting ANSI Z124.3 or ANSI Z124.6, having minimum physical and performance properties specified.
- B. **SS01:** Corian Neutral Concrete: matte finish, for use at Miscellaneous Countertops & at window sills.
- C. Configuration: Unless otherwise indicated, provide countertops with the following front and backsplash style:
 - 1. Front: 1/4-inch (6.5-mm) Radius top edge with apron, 2 inches (50 mm) high with 1/8-inch (9.5-mm) radius.
 - 2. Backsplash: Radius edge with 1/4-inch (9.5-mm) radius.
 - 3. Endsplash: Matching backsplash.
- D. Countertops: 1/2-inch- (12.7-mm-) thick, solid surface material with front edge built up with same material.
- E. Backsplashes: 1/2-inch- (12.7-mm-) thick, solid surface material.
- F. Windowsills: 1/2-inch- (12.7-mm-) thick, solid surface material. 1/4" radius edges.
- G. Fabrication: Fabricate tops in one piece with shop-applied edges and backsplashes unless otherwise indicated. Comply with solid-surface-material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
 - 1. Fabricate with loose backsplashes for field assembly.

2.2 FASTENINGS

- A. Adhesive: Suitable for the purpose; not containing formaldehyde or other volatile organic compounds.

2.3 ACCESSORIES

- A. Mounting Adhesive:
 - 1. Provide structural grade 50-year 100% silicone or epoxy adhesive.
 - a. Adhesive or as otherwise recommended by manufacturer.
- B. Joint Sealant:

1. Clear sealant of type recommended by manufacturer for application and use.
2. Provide anti-bacterial type in toilet, bath, food preparation

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Provide backsplashes and end splashes as indicated on the drawings. Adhere to countertops using manufacturer's standard color-matched silicone sealant.
- B. Install countertops level to a tolerance of 1/8 inch in 8 feet (3 mm in 2.4 m).
- C. Allow gaps for expansion of not less than 1/8 inch (1.5mm) per 10 feet when installed between walls or other fixed structure.
- D. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Pre-drill holes for screws as recommended by manufacturer. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
 1. Install backsplashes and end splashes to comply with manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
 2. Seal edges of cutouts in particleboard subtops by saturating with varnish.
- E. Secure countertops to subtops with adhesive according to manufacturer's written instructions. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
- F. Bond joints with adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.
 1. Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.
- G. Install backsplashes and end splashes by adhering to wall and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.
- H. Install aprons to backing and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears. Fasten by screwing through backing. Predrill holes for screws as recommended by manufacturer.
- I. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance.:
 1. Cutouts shall have a minimum of 1/4" inch (6.35mm) radius.
 2. Where edges of cutouts will be exposed in finished work; polish edges.
 3. Seal edges of cutouts in particleboard subtops by saturating with varnish.
- J. Apply sealant to gaps at walls; comply with Section 079200 "Joint Sealants."
- K. Seal joint between back/end splashes and vertical surfaces.
- L. Where underside of counter is visible provide finish material or provide paint in color acceptable to Architect.

END OF SECTION 123661

SECTION 21 0100 – BASIC FIRE PROTECTION REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Specification Sections, apply to this and the other sections of Division 21.

1.2 SUMMARY

- A. This Section includes general administrative and procedural requirements for fire protection installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 01:
 - 1. Submittals.
 - 2. Material and Equipment Selection.
 - 3. Coordination drawings.
 - 4. Record documents.
 - 5. Maintenance manuals.

1.3 REFERENCED STANDARDS

- A. International Fire Code 2018 (IFC)
- B. National Fire Protection Association Standards

1.4 CONTRACTOR'S SUBMITTAL REVIEW RESPONSIBILITIES

- A. General: Submittals are not requested for all products covered in the specifications. Submit only the data requested under the submittals portion of each specification section or where indicated in a Submittal Log, if included within Division 01. Un-requested submittals will not be processed, reviewed or returned and the contractor will be notified that the submittal will not be reviewed by the engineer of record.
 - 1. Non-requirement of submittals, when so noted, is not to be construed as an allowance for substitutions and does not relieve the contractor from full compliance with the plans and specifications.
 - 2. Any deviation from specified items is considered a substitution. If the contractor desires to use other than specified items, then a formal request for substitution must be submitted prior to bid date (no exceptions), in accordance with the procedures and time limitations set forth in Division 01. Where not defined in Division 01, requests for substitutions shall be submitted no less than ten (10) working days prior to bid date. Review of substitution requests by the Engineer shall be done at the expense of the contractor. Charges for this substitution review shall be calculated based on the Engineer's standard hourly rates, as defined in their contract with the Owner.
- B. It is the responsibility of the Contractor to ensure that all submittals have been reviewed for total completeness and accuracy as to the requirements of the specifications and drawings before being submitted to the Engineer for review.
 - 1. One comprehensive submittal shall be provided for each individual specification section. All required submittal information called for in each individual specification section shall be included in the submittal.
 - 2. The Engineer of Record shall not be responsible for informing the contractor on items that have not been included and are necessary for a complete review of the required submittal information for a specification section.
 - 3. The Engineer of Record shall have the option of returning any submittal, unmarked, if all required documentation called for in the specifications has not been provided in the submittal.
 - 4. The Engineer of Record shall review each submittal no more than two (2) times and return to the contractor with the appropriate disposition.
 - 5. If the Engineer of Record is required to review a submittal a second time, it shall be limited to review of the changed information, clearly highlighted by the submitter, and/or confirmation of documentation only and it shall be returned to the contractor with the appropriate disposition.
 - 6. If the submittal is required to be reviewed a third time, it shall be done at the expense of the contractor. Charges for this additional submittal review shall be calculated based on the Engineer's standard hourly rates, as defined in their contract with the Owner.
- C. Operation and Maintenance Manuals: All items required for insertion into each Operation and Maintenance (O&M) Manual are called out in the submittals portion of each specification section or in a Submittal Log, if included within Division 01. It is the responsibility of the Contractor to ensure that the O&M submittal has been

reviewed and includes all the requirements of the specifications. The Engineer of Record shall review the submittal for the Operation and Maintenance Manual one (1) time and return to the contractor with the appropriate disposition.

1. If the submittal is required to be reviewed a second time, it shall be done at the expense of the contractor. Charges for this additional submittal review shall be calculated based on the Engineer's standard hourly rates, as defined in their contract with the Owner.
2. Submittals for the Operation and Maintenance Manual must be original documentation.
3. Photo copies of marked up Operations and Maintenance submittals are not acceptable.

D. Refer to Division 01 and each individual Division 21 Section for additional submittal requirements.

E. Prepare maintenance manuals in accordance with Division 01. In addition to the requirements specified in Division 01, 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.
5. Facsimiles or photo copies are not allowed as submittals for operating and maintenance manuals. Submittals for operating and maintenance manuals must be on original manufacturer printed stock.

F. Prepare and submit Coordination Drawings as further described herein. The Engineer shall receive one copy of all coordination drawings supplied to the Owner as required in this specification. It is the responsibility of the Contractor to coordinate the work as outlined herein. Receipt by the Engineer of a copy of the coordination drawings is to verify conformance to the submittal requirements set forth in this specification section. It is not an admission by the Engineer as to the accuracy or completeness of the coordination proposed.

G. Coordination shall be drawn to a scale of $\frac{1}{4}" = 1'0"$ or larger. Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:

1. Planned piping layout, including valve and specialty locations and valve-stem movement. Include all piping including but not limited to Fire Protection piping, HVAC piping, and Plumbing piping. Include ceiling and wall-mounted access doors and panels required to provide access to valves and other operating devices.
2. Planned ductwork layout, including terminal units, dampers and specialty locations, with terminal unit and damper operator clearances. Include ceiling and wall-mounted access doors and panels required to provide access to dampers and other operating devices.
3. Clearances for installing and maintaining insulation.
4. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
5. Equipment and accessory service connections and support details.
6. Exterior wall and foundation penetrations.
7. Fire-rated wall and floor penetrations.
8. Sizes and location of required concrete pads and bases.
9. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
10. Floor plans, elevations, and details to indicate penetrations in floors, walls, ceilings and roofs, and their relationship to other penetrations and installations.
11. Ceiling plans showing coordination of mechanical, electrical, structural, ceiling suspension assembly, lighting, security, communications, fire alarm, plumbing, and fire protection work within allotted space.
12. Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, access panels, special moldings, and other ceiling-mounted items.

13. Floor plans and sections of fan rooms and mechanical rooms; show layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.
- H. Prepare record documents in accordance with the requirements in Division 01. In addition to the requirements specified in Division 01, indicate the following installed conditions:
 1. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located. Indicate actual inverts and horizontal locations of all underground piping.
 2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
 3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
 4. Contract Modifications, actual equipment and materials installed.
- I. Comply with each individual Division 21 Section for additional submittal requirements.

1.5 MATERIAL AND EQUIPMENT SELECTION

- A. Product Options: The specification of each item of major mechanical equipment required for the project may include a list of manufacturers, with one "basis of design" manufacturer, type, and model identified by virtue of their listing in the equipment schedule on the Drawings. Where several manufacturers in addition to the "basis of design" manufacturer are listed in the specifications, it shall be understood that the words "or approved equal by" are implied to precede each of the other manufacturer's names.
 1. The manufacturers other than the "basis of design" may be furnished at the contractor's option in lieu of the "basis of design" product, provided that the selected manufacturer's product is equal in all material and functional respects. In addition to submittal requirements that may be specified in this section, submit a line-by-line written verification of the applicable specification section(s) identifying compliance with or variations from the specified features, materials, performance, capacities, weight, size, durability, energy consumption and efficiency, warranty, and visual impact (if exposed to view by other than maintenance persons). The burden of proof of manufacturer/product equality is on the contractor.
 2. Where a product is not scheduled on the drawings and, therefore, where no "basis of design" is indicated, selection among all of the listed manufacturers and products is at the contractor's option, subject to the requirements of the Contract Documents.
 3. Products of manufacturers not listed in the Contract Documents are considered Substitutions and are not permitted, except as provided under the General and Supplementary Conditions and Division 01 Specifications. Full compliance with Division 01 section "Product Substitutions" is mandatory for acceptance of products or manufacturers not listed.
- B. Listing of a manufacturer does not imply approval of that manufacturer's standard product or products. Rather, listing of a manufacturer indicates only a general acceptance of that manufacturer's name and reputation. Final approval is subject to full compliance with these Contract Documents.
- C. Model numbers identified on the Drawings notwithstanding, all equipment must comply with the requirements of these Contract Documents. Do not assume that a manufacturer's standard product is acceptable as is. For example, one or more custom modifications, custom colors or finishes, manufacturer's options, and/or accessories may be required to meet the specified requirements.
- D. Where drawings indicate sizes, profiles, connections, and dimensional requirements of material and equipment, these are based on the "basis of design" manufacturer, type and model indicated. In the event that equipment of power, dimensions, capacities, layout, connections, and/or ratings differing from the "basis of design" are selected by the contractor and approved by the Owner's representative, any necessary adjustments are the contractor's responsibility. All connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, pipe and duct sizes, pipe and duct layout, and the like shall be adjusted by the contractor to suit the equipment provided. No additional costs will be approved for these changes. Should revisions to the design because of contractor's selection of manufacturer, type, or model other than the "basis of design" require additional review and/or redesign by an Architect or Engineer, the contractor shall reimburse the Owner for Owner's added professional fee expenses.
- E. Where two or more materials are listed in the "Part 2 – Products" subsection of any Division 21 section, do not assume that the selection of materials is the contractor's option. Refer to "Part 3 – Execution" subsection of that same Division 21 section for an explanation of which specific material(s) shall be used for which specific application(s). For example, Part 2 may list several types and grades of piping, and Part 3 will describe which type and grade of pipe to use for a given application.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. Protect stored on-site or installed absorptive materials from moisture damage. Materials directly exposed to moisture via precipitation, water leaks, or condensation shall be removed from the jobsite and replaced.

END OF SECTION 210100

SECTION 21 0500 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

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. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Sleeves.
 - 3. Escutcheons.
 - 4. Grout.
 - 5. Equipment installation requirements common to equipment sections.
 - 6. Painting and finishing.
 - 7. Supports and anchorages.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
 - 1. CPVC: Chlorinated polyvinyl chloride plastic.
- G. The following are industry abbreviations for rubber materials:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. NBR: Acrylonitrile-butadiene rubber.

1.4 CONTRACTOR'S SUBMITTAL REVIEW RESPONSIBILITIES

- A. General: Submittals are not requested for all products covered in the specifications. Submit only the data requested under the submittals portion of each specification section or where indicated in a Submittal Log, if included within Division 01. Un-requested submittals will not be processed, reviewed or returned and the contractor will be notified that the submittal will not be reviewed by the engineer of record.
 - 1. Non-requirement of submittals, when so noted, is not to be construed as an allowance for substitutions and does not relieve the contractor from full compliance with the plans and specifications.
 - 2. Any deviation from specified items is considered a substitution. If the contractor desires to use other than specified items, then a formal request for substitution must be submitted prior to bid date (no exceptions), in accordance with the procedures and time limitations set forth in Division 01. Where not defined in Division 01, requests for substitutions shall be submitted no less than ten (10) working days prior to bid date. Review of substitution requests by the Engineer shall be done at the expense of the contractor. Charges for this substitution review shall be calculated based on the Engineer's standard hourly rates, as defined in their contract with the Owner.
- B. It is the responsibility of the Contractor to ensure that all submittals have been reviewed for total completeness and accuracy as to the requirements of the specifications and drawings before being submitted to the Engineer for review.

1. One comprehensive submittal shall be provided for each individual specification section. All required submittal information called for in each individual specification section shall be included in the submittal.
 2. The Engineer of Record shall not be responsible for informing the contractor on items that have not been included and are necessary for a complete review of the required submittal information for a specification section.
 3. The Engineer of Record shall have the option of returning any submittal, unmarked, if all required documentation called for in the specifications has not been provided in the submittal.
 4. The Engineer of Record shall review each submittal no more than two (2) times and return to the contractor with the appropriate disposition.
 5. If the Engineer of Record is required to review a submittal a second time, it shall be limited to review of the changed information, clearly highlighted by the submitter, and/or confirmation of documentation only and it shall be returned to the contractor with the appropriate disposition.
 6. If the submittal is required to be reviewed a third time, it shall be done at the expense of the contractor. Charges for this additional submittal review shall be calculated based on the Engineer's standard hourly rates, as defined in their contract with the Owner.
- C. Operation and Maintenance Manuals: All items required for insertion into each Operation and Maintenance (O&M) Manual are called out in the submittals portion of each specification section or in a Submittal Log, if included within Division 01. It is the responsibility of the Contractor to ensure that the O&M submittal has been reviewed and includes all the requirements of the specifications. The Engineer of Record shall review the submittal for the Operation and Maintenance Manual one (1) time and return to the contractor with the appropriate disposition.
1. If the submittal is required to be reviewed a second time, it shall be done at the expense of the contractor. Charges for this additional submittal review shall be calculated based on the Engineer's standard hourly rates, as defined in their contract with the Owner.
 2. Submittals for the Operation and Maintenance Manual must be original documentation.
 3. Photo copies of marked up Operations and Maintenance submittals are not acceptable.
- D. Coordination Drawings: Prepare and submit Coordination Drawings as further described herein and as indicated in the Special Conditions. The Engineer shall receive one copy of all coordination drawings supplied to the Owner as required in this specification. It is the responsibility of the Contractor to coordinate the work as outlined herein. Receipt by the Engineer of a copy of the coordination drawings is to verify conformance to the submittal requirements set forth in this specification section. It is not an admission by the Engineer as to the accuracy or completeness of the coordination proposed.
- E. Refer to Division 01 and each individual Division 23 Section for additional submittal requirements.

1.5 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Fire-Suppression Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

1.7 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for fire-suppression installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

- C. Coordinate requirements for access panels and doors for fire-suppression items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 21 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. Refer to individual Division 21 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with set screws.
- E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe: ASTM D 1785, Schedule 40.
- G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.5 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Stamped-Steel Type: With set screw and chrome-plated finish.

2.6 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 21 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - g. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.
 - h. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
 - i. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
- M. Sleeves are not required for core-drilled holes.
- N. Permanent sleeves are not required for holes formed by removable PE sleeves.
- O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
- P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

- a. PVC or Steel Pipe Sleeves: For pipes smaller than NPS 6.
- b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
- c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

- 1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

Q. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

R. Verify final equipment locations for roughing-in.

S. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 21 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 PAINTING

A. Painting of fire-suppression systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.4 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor fire-suppression materials and equipment.

- C. Field Welding: Comply with AWS D1.1.

3.5 GROUTING

- A. Mix and install grout for fire-suppression equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION 210500

SECTION 21 0553 - IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

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. Pipe labels.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service and showing flow direction according to ASME A13.1.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: Size letters according to ASME A13.1 for piping.
- E. Pipe-Label Colors:
 - 1. Background Color: Safety Red.
 - 2. Letter Color: White.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be installed.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 PIPE LABEL INSTALLATION

- A. Piping: Painting of piping is specified in Section 099123 "Interior Painting."
- B. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection excluding short takeoffs. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit a view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

- C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes including pipes where flow is allowed in both directions.

END OF SECTION 210553

SECTION 21 1000 - WATER-BASED FIRE-SUPPRESSION SYSTEMS

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. This Section includes the following fire-suppression piping inside the building:
 - 1. Wet-pipe sprinkler systems.
- B. Related Sections include the following:
 - 1. Division 10 Section "Fire Extinguisher Cabinets" and "Fire Extinguishers" for cabinets and fire extinguishers.
 - 2. Division 28 Section "Fire Detection and Alarm" for alarm devices not specified in this Section.

1.3 DEFINITIONS

- A. CPVC: Chlorinated polyvinyl chloride plastic.
- B. CR: Chlorosulfonated polyethylene synthetic rubber.
- C. High-Pressure Piping System: Fire-suppression piping system designed to operate at working pressure higher than standard 175 psig.
- D. PE: Polyethylene plastic.
- E. Underground Service-Entrance Piping: Underground service piping below the building.

1.4 SYSTEM DESCRIPTIONS

- A. Combined Standpipe and Sprinkler System: Fire-suppression system with both standpipe and sprinkler systems. Sprinkler system is supplied from standpipe system.
- B. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

1.5 PERFORMANCE REQUIREMENTS

- A. Standard Piping System Component Working Pressure: Listed for at least 175 psig.
- B. Fire-suppression standpipe system design shall be approved by authorities having jurisdiction.
 - 1. Minimum residual pressure at each hose-connection outlet is the following:
 - a. NPS 2-1/2 Hose Connections: 100 psig.
 - 2. Unless otherwise indicated, the following is maximum residual pressure at required flow at each hose-connection outlet:
 - a. NPS 2-1/2 Hose Connections: 175 psig.
- C. Fire-suppression sprinkler system design shall be approved by authorities having jurisdiction.
 - 1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
 - 2. Minimum Density for Automatic-Sprinkler Piping Design:
 - a. Light Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
 - b. Ordinary Hazard Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
 - 3. Maximum Protection Area per Sprinkler: Per UL listing.
 - 4. Maximum Protection Area per Sprinkler:
 - a. Office Spaces: 225 sq. ft.
 - b. Storage Areas: 130 sq. ft.

- c. Mechanical Equipment Rooms: 130 sq. ft.
 - d. Electrical Equipment Rooms: 130 sq. ft.
 - e. Other Areas: According to NFPA 13 recommendations, unless otherwise indicated.
5. Total Combined Hose-Stream Demand Requirement: According to FM Global, unless otherwise indicated:
- a. Light-Hazard Occupancies: 100 gpm for 30 minutes.
 - b. Ordinary-Hazard Occupancies: 250 gpm for 60 to 90 minutes.
- D. Seismic Performance: Fire-suppression piping shall be capable of withstanding the effects of earthquake motions determined according to NFPA 13 and ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."

1.6 SUBMITTALS

- A. Product Data: For the following:
- 1. Piping materials, including sprinkler specialty fittings.
 - 2. Pipe hangers and supports, including seismic restraints.
 - 3. Valves, including listed fire-protection valves, unlisted general-duty valves, and specialty valves and trim.
 - 4. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other pertinent data.
 - 5. Hose connections, including size, type, and finish.
 - 6. Monitors.
 - 7. Alarm devices, including electrical data.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13 and FM Global, that have been approved by authorities having jurisdiction, including hydraulic calculations, if applicable.
- D. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13 and NFPA 14. Include "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping."
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For standpipe and sprinkler specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
- 1. Installer's responsibilities include designing, fabricating, and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
- B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
- C. NFPA Standards: Fire-suppression-system equipment, specialties, accessories, installation, and testing shall comply with the following:
- 1. NFPA 13, "Installation of Sprinkler Systems."
 - 2. NFPA 14, "Installation of Standpipe, Private Hydrant, and Hose Systems."

1.8 COORDINATION

- A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.9 EXTRA MATERIALS

- 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. Sprinkler Cabinets: Finished, wall-mounting, steel cabinet with hinged cover, with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler on Project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE AND FITTINGS

- A. Threaded-End, Standard-Weight Schedule 40 Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, with factory- or field-formed threaded ends.
1. Cast-Iron Threaded Flanges: ASME B16.1.
 2. Malleable-Iron Threaded Fittings: ASME B16.3.
 3. Gray-Iron Threaded Fittings: ASME B16.4.
 4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe. Include ends matching joining method.
 5. Steel Threaded Couplings: ASTM A 865.
- B. Grooved-End, Standard-Weight Schedule 40 Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, with factory- or field-formed, square-cut or roll-grooved ends.
1. Grooved-Joint Piping Systems:
 - a. Manufacturers:
 - 1) Anvil International, Inc.
 - 2) Shurjoint Piping Products, Inc.
 - 3) Victaulic Co. of America.
 - 4) Ward Manufacturing.
 - b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
 - c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, rubber gasket listed for use with housing, and steel bolts and nuts.

2.3 DIELECTRIC FITTINGS

- A. Assembly shall be copper alloy, ferrous, and insulating materials with ends matching piping system.
- B. Dielectric Unions: Factory-fabricated assembly, designed for 250-psig minimum working pressure at 180 degrees F. Include insulating material that isolates dissimilar materials and ends with inside threads according to ASME B1.20.1.
1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Epco Sales, Inc.
 - d. Hart Industries International, Inc.
 - e. Watts Industries, Inc.; Water Products Div.
 - f. Zurn Industries, Inc.; Wilkins Div.

2.4 SPRINKLER SPECIALTY FITTINGS

- A. Sprinkler specialty fittings shall be UL listed and FM Global approved, with 175-psig minimum working-pressure rating, and made of materials compatible with piping. Sprinkler specialty fittings shall have 250-psig minimum working-pressure rating if fittings are components of high-pressure piping system.
- B. Outlet Specialty Fittings:
 - 1. Manufacturers:
 - a. Anvil International, Inc.
 - b. National Fittings, Inc.
 - c. Victaulic Co. of America.
 - d. Ward Manufacturing.
- C. Sprinkler Drain and Alarm Test Fittings: Cast- or ductile-iron body; with threaded or locking-lug inlet and outlet, test valve, and orifice and sight glass.
 - 1. Manufacturers:
 - a. Fire-End and Croker Corp.
 - b. Viking Corp.
 - c. Victaulic Co. of America.
- D. Sprinkler Branch-Line Test Fittings: Brass body with threaded inlet, capped drain outlet, and threaded outlet for sprinkler.
 - 1. Manufacturers:
 - a. Elkhart Brass Mfg. Co., Inc.
 - b. Fire-End and Croker Corp.
 - c. Potter-Roemer; Fire-Protection Div.
- E. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.
 - 1. Manufacturers:
 - a. AGF Manufacturing Co.
 - b. Central Sprinkler Corp.
 - c. G/J Innovations, Inc.
 - d. Triple R Specialty of Ajax, Inc.
- F. Drop-Nipple Fittings: UL 1474, adjustable with threaded inlet and outlet, and seals.
 - 1. Manufacturers:
 - a. CECA, LLC.
 - b. Merit.
- G. Flexible, Sprinkler Hose Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Victaulic Company.
 - 2. Standard: UL 1474.
 - 3. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
 - 4. Pressure Rating: 175 psig minimum.
 - 5. Size: Same as connected piping, for sprinkler.

2.5 LISTED FIRE-PROTECTION VALVES

- A. Valves shall be UL listed and FM Global approved, with 175-psig minimum pressure rating. Valves shall have 250-psig minimum pressure rating if valves are components of high-pressure piping system.
- B. Gate Valves with Wall Indicator Posts:

1. Gate Valves: UL 262, cast-iron body, bronze mounted, with solid disc, nonrising stem, operating nut, and flanged ends.
2. Manufacturers:
 - a. Grinnell Fire Protection.
 - b. McWane, Inc.; Kennedy Valve Div.
 - c. NIBCO.
 - d. Stockham.
- C. Ball Valves: Comply with UL 1091, except with ball instead of disc.
 1. NPS 1-1/2 and Smaller: Bronze body with threaded ends.
 2. NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
 3. NPS 3: Ductile-iron body with grooved ends.
 4. Manufacturers:
 - a. NIBCO.
 - b. Victaulic Co. of America.
- D. Butterfly Valves: UL 1091.
 1. NPS 2 and Smaller: Bronze body with threaded ends.
 - a. Manufacturers:
 - 1) Global Safety Products, Inc.
 - 2) Milwaukee Valve Company.
 2. NPS 2-1/2 and Larger: Bronze, cast-iron, or ductile-iron body; wafer type or with flanged or grooved ends.
 - a. Manufacturers:
 - 1) Global Safety Products, Inc.
 - 2) McWane, Inc.; Kennedy Valve Div.
 - 3) Mueller Company.
 - 4) NIBCO.
 - 5) Victaulic Co. of America.
- E. Check Valves NPS 2 and Larger: UL 312, swing type, cast-iron body with flanged or grooved ends.
 1. Manufacturers:
 - a. Clow Valve Co.
 - b. Globe Fire Sprinkler Corporation.
 - c. Grinnell Fire Protection.
 - d. Hammond Valve.
 - e. McWane, Inc.; Kennedy Valve Div.
 - f. Mueller Company.
 - g. NIBCO.
 - h. Potter-Roemer; Fire Protection Div.
 - i. Reliable Automatic Sprinkler Co., Inc.
 - j. Victaulic Co. of America.
 - k. Watts Industries, Inc.; Water Products Div.
- F. Gate Valves: UL 262, OS&Y type.
 1. NPS 2 and Smaller: Bronze body with threaded ends.
 - a. Manufacturers:
 - 1) Crane Co.; Crane Valve Group; Crane Valves.
 - 2) Hammond Valve.
 - 3) NIBCO.
 - 4) United Brass Works, Inc.
 2. NPS 2-1/2 and Larger: Cast-iron body with flanged ends.

- a. Manufacturers:
 - 1) Clow Valve Co.
 - 2) Hammond Valve.
 - 3) Milwaukee Valve Company.
 - 4) Mueller Company.
 - 5) NIBCO.
 - 6) United Brass Works, Inc.
- G. Indicating Valves: UL 1091, with integral indicating device and ends matching connecting piping.
 - 1. Indicator: Electrical, 115-V ac, prewired, single-circuit, supervisory switch or Electrical, 115-V ac, prewired, 2-circuit, supervisory switch.
 - 2. NPS 2 and Smaller: Ball or butterfly valve with bronze body and threaded ends.
 - a. Manufacturers:
 - 1) Milwaukee Valve Company.
 - 2) NIBCO.
 - 3) Victaulic Co. of America.
 - 3. NPS 2-1/2 and Larger: Butterfly valve with cast- or ductile-iron body; wafer type or with flanged or grooved ends.
 - a. Manufacturers:
 - 1) Grinnell Fire Protection.
 - 2) McWane, Inc.; Kennedy Valve Div.
 - 3) Milwaukee Valve Company.
 - 4) NIBCO.
 - 5) Victaulic Co. of America.

2.6 SPECIALTY VALVES

- A. Sprinkler System Control Valves: UL listed and FM Global approved, cast- or ductile-iron body with flanged or grooved ends, and 175-psig minimum pressure rating. Control valves shall have 250-psig minimum pressure rating if valves are components of high-pressure piping system.
 - 1. Manufacturers:
 - a. Globe Fire Sprinkler Corporation.
 - b. Grinnell Fire Protection.
 - c. Reliable Automatic Sprinkler Co., Inc.
 - d. Victaulic Co. of America.
 - e. Viking Corp.
 - 2. Alarm Check Valves: UL 193, designed for horizontal or vertical installation, with bronze grooved seat with O-ring seals, single-hinge pin, and latch design. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, [**retarding chamber**,] and fill-line attachment with strainer.
 - a. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
 - b. Drip Cup Assembly: Pipe drain with check valve to main drain piping.
- B. Automatic Drain Valves: UL 1726, NPS 3/4, ball-check device with threaded ends.
 - 1. Manufacturers:
 - a. AFAC Inc.
 - b. Grinnell Fire Protection.

2.7 SPRINKLERS

- A. Sprinklers shall be UL listed and FM Global approved, with 175-psig minimum pressure rating. Sprinklers shall have 250-psig minimum pressure rating if sprinklers are components of high-pressure piping system.
- B. Manufacturers:
 - 1. Reliable Automatic Sprinkler Co., Inc.
 - 2. Tyco Fire & Building Products

3. Victaulic
4. Viking Corp.
- C. Automatic Sprinklers: With heat-responsive element complying with the following:
 1. UL 199, for nonresidential applications.
- D. Sprinkler Types and Categories: Nominal 1/2-inch orifice for "Ordinary" temperature classification rating, unless otherwise indicated or required by application.
 1. Open Sprinklers: UL 199, without heat-responsive element.
 - a. Orifice: 1/2 inch, with discharge coefficient K between 5.3 and 5.8.
 - b. Orifice: 17/32 inch, with discharge coefficient K between 7.4 and 8.2.
- E. Sprinkler types, features, and options as follows:
 1. Concealed ceiling sprinklers, including cover plate.
 2. Extended-coverage sprinklers.
 3. Flush ceiling sprinklers, including escutcheon.
 4. Pendent sprinklers.
 5. Pendent, dry-type sprinklers.
 6. Quick-response sprinklers.
 7. Recessed sprinklers, including escutcheon.
 8. Sidewall sprinklers.
 9. Sidewall, dry-type sprinklers.
 10. Upright sprinklers.
- F. Sprinkler Finishes: Chrome plated, bronze, and painted.
- G. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
 1. Ceiling Mounting: Plastic, white finish, one piece, flat.
 2. Sidewall Mounting: Plastic, white finish, one piece, flat.
- H. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler.

2.8 HOSE CONNECTIONS

- A. Manufacturers:
 1. AFAC Inc.
 2. Central Sprinkler Corp.
 3. Elkhart Brass Mfg. Co., Inc.
 4. Fire-End and Croker Corp.
 5. Fire Protection Products, Inc.
 6. GMR International Equipment Corporation.
 7. Grinnell Fire Protection.
 8. Guardian Fire Equipment Incorporated.
 9. McWane, Inc.; Kennedy Valve Div.
 10. Mueller Company.
 11. Potter-Roemer; Fire-Protection Div.
 12. United Brass Works, Inc.

- B. Description: UL 668, brass or bronze, 300-psig minimum pressure rating, hose valve for connecting fire hose. Include angle or gate pattern design; female NPS inlet and male hose outlet; and lugged cap, gasket, and chain. Include NPS 1-1/2 or NPS 2-1/2 as indicated, and hose valve threads according to NFPA 1963 and matching local fire department threads.

1. Valve Operation: Nonadjustable type.
2. Finish: Rough metal or chrome-plated.

2.9 ALARM DEVICES

- A. Alarm-device types shall match piping and equipment connections.
- B. Water-Flow Indicator: UL 346, electrical-supervision, paddle-operated-type, water-flow detector with 250-psig pressure rating and designed for horizontal or vertical installation. Include two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
1. Manufacturers:
 - a. ADT Security Services, Inc.
 - b. Grinnell Fire Protection.
 - c. ITT McDonnell & Miller.
 - d. Potter Electric Signal Company.
 - e. System Sensor.
 - f. Viking Corp.
 - g. Watts Industries, Inc.; Water Products Div.
- C. Pressure Switch: UL 753, electrical-supervision-type, water-flow switch with retard feature. Include single-pole, double-throw, normally closed contacts and design that operates on rising pressure and signals water flow.
1. Manufacturers:
 - a. Grinnell Fire Protection.
 - b. Potter Electric Signal Company.
 - c. System Sensor.
 - d. Viking Corp.
- D. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.
1. Manufacturers:
 - a. McWane, Inc.; Kennedy Valve Div.
 - b. Potter Electric Signal Company.
 - c. System Sensor.

2.10 PRESSURE GAGES

- A. Manufacturers:
1. AGF Manufacturing Co.
 2. AMETEK, Inc.; U.S. Gauge.
 3. Brecco Corporation.
 4. Dresser Equipment Group; Instrument Div.
 5. Marsh Bellofram.
 6. WIKA Instrument Corporation.
- B. Description: UL 393, 3-1/2- to 4-1/2-inch- diameter, dial pressure gage with range of [0 to 250 psig minimum.
1. Water System Piping: Include caption "WATER" or "AIR/WATER" on dial face.
 2. Air System Piping: Include retard feature and caption "AIR" or "AIR/WATER" on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13, NFPA 14, and NFPA 291. Use results for system design calculations required in Part 1 "Quality Assurance" Article.
- B. Report test results promptly and in writing.

3.2 EARTHWORK

- A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.3 EXAMINATION

- A. Examine roughing-in for hose connections and stations to verify actual locations of piping connections before installation.
- B. Examine walls and partitions for suitable thicknesses, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.4 PIPING APPLICATIONS, GENERAL

- A. Shop weld pipe joints where welded piping is indicated.
- B. Do not use welded joints for galvanized-steel pipe.
- C. Flanges, flanged fittings, unions, nipples, and transition and special fittings with finish and pressure ratings same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.
- D. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends; cast- or malleable-iron threaded fittings; and threaded joints.
- E. Underground Service-Entrance Piping: Ductile-iron, mechanical-joint pipe and fittings and restrained joints. Include corrosion-protective encasement.

3.5 SPRINKLER SYSTEM PIPING APPLICATIONS

- A. Standard-Pressure, Wet-Pipe Sprinkler System, 175-psig Maximum Working Pressure:
 - 1. NPS 1-1/4 and Smaller: Threaded-end, black, standard-weight Schedule 40 steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
 - 2. NPS 1-1/2 and larger: Grooved-end, black, standard-weight Schedule 40 steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

3.6 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Listed Fire-Protection Valves: UL listed and FM Global approved for applications where required by NFPA 13 and NFPA 14.
 - a. Shutoff Duty: Use ball or butterfly valves.

3.7 JOINT CONSTRUCTION

- A. Refer to Division 21 Section "Common Work Results for Fire Suppression" for basic piping joint construction.
- B. Threaded Joints: Comply with NFPA 13 for pipe thickness and threads. Do not thread pipe smaller than NPS 8 with wall thickness less than Schedule 40 unless approved by authorities having jurisdiction and threads are checked by a ring gage and comply with ASME B1.20.1.
- C. Grooved Joints: Assemble joints with listed coupling and gasket, lubricant, and bolts.
 - 1. Steel Pipe: Square-cut or roll-groove piping as indicated. Use grooved-end fittings and rigid, grooved-end-pipe couplings, unless otherwise indicated.
 - 2. Dry-Pipe Systems: Use fittings and gaskets listed for dry-pipe service.

3.8 PIPING INSTALLATION

- A. Refer to Division 21 Section "Common Work Results for Fire Suppression" for basic piping installation.
- B. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- C. Install underground ductile-iron service-entrance piping according to NFPA 24 and with restrained joints.
- D. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install unions adjacent to each valve in pipes NPS 2 and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.
- F. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections.
- G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13.
- H. Install sprinkler piping with drains for complete system drainage.
- I. Install sprinkler zone control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- J. Install alarm devices in piping systems.
- K. Hangers and Supports: Comply with NFPA 13 for hanger materials.
 - 1. Install standpipe system piping according to NFPA 14.
 - 2. Install sprinkler system piping according to NFPA 13.
- L. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.
- M. Fill wet-pipe sprinkler system piping with water.

3.9 VALVE INSTALLATION

- A. Install listed fire-protection valves, unlisted general-duty valves, specialty valves and trim, controls, and specialties according to NFPA 13 and NFPA 14 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water supply sources.
- D. Specialty Valves:
 - 1. Alarm Check Valves: Install in vertical position for proper direction of flow, including bypass check valve and retarding chamber drain-line connection.

3.10 SPRINKLER APPLICATIONS

- A. Drawings indicate sprinkler types to be used. Where specific types are not indicated, use the following sprinkler types:
 - 1. Rooms without Ceilings: Upright and pendant sprinklers.
 - 2. Rooms with Suspended Ceilings: Concealed sprinklers.
 - 3. Wall Mounting: Sidewall sprinklers.
 - 4. Spaces Subject to Freezing: Dry sprinklers.

5. Special Applications: Extended-coverage and quick-response sprinklers where indicated.
6. Sprinkler Finishes shall be the following except as otherwise noted on drawings:
 - a. Upright, Pendent, and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view.
 - b. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.

3.11 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels and tiles.
- B. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space.
- C. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.

3.12 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Connect piping to specialty valves, hose valves, specialties, fire department connections, and accessories.
- D. Electrical Connections: Power wiring is specified in Division 26.
- E. Connect alarm devices to fire alarm.
- F. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- G. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- H. 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 and UL 486B.

3.13 LABELING AND IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and NFPA 14.

3.14 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 3. Energize circuits to electrical equipment and devices.
 4. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 5. Coordinate with fire alarm tests. Operate as required.
 6. Verify that equipment hose threads are same as local fire department equipment.
- B. Report test results promptly and in writing to Architect and authorities having jurisdiction.

3.15 CLEANING AND PROTECTION

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.
- C. Protect sprinklers from damage until Substantial Completion.

3.16 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 211000

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SECTION 22 0100 – BASIC PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Specification Sections, apply to this and the other sections of Division 22.

1.2 SUMMARY

- A. This Section includes general administrative and procedural requirements for plumbing installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 01:
 - 1. Submittals.
 - 2. Material and Equipment Selection.
 - 3. Coordination drawings.
 - 4. Record documents.
 - 5. Maintenance manuals.

1.3 REFERENCED STANDARDS

- A. International Plumbing Code 2021 (IPC)
- B. ASHRAE Standard 90.1, Energy Efficiency Design of New Buildings Except Low-Rise Residential Buildings.

1.4 CONTRACTOR'S SUBMITTAL REVIEW RESPONSIBILITIES

- A. General: Submittals are not requested for all products covered in the specifications. Submit only the data requested under the submittals portion of each specification section or where indicated in a Submittal Log, if included within Division 01. Un-requested submittals will not be processed, reviewed or returned and the contractor will be notified that the submittal will not be reviewed by the engineer of record.
 - 1. Non-requirement of submittals, when so noted, is not to be construed as an allowance for substitutions and does not relieve the contractor from full compliance with the plans and specifications.
 - 2. Any deviation from specified items is considered a substitution. If the contractor desires to use other than specified items, then a formal request for substitution must be submitted prior to bid date (no exceptions), in accordance with the procedures and time limitations set forth in Division 01. Where not defined in Division 01, requests for substitutions shall be submitted no less than ten (10) working days prior to bid date. Review of substitution requests by the Engineer shall be done at the expense of the contractor. Charges for this substitution review shall be calculated based on the Engineer's standard hourly rates, as defined in their contract with the Owner.
- B. It is the responsibility of the Contractor to ensure that all submittals have been reviewed for total completeness and accuracy as to the requirements of the specifications and drawings before being submitted to the Engineer for review.
 - 1. One comprehensive submittal shall be provided for each individual specification section. All required submittal information called for in each individual specification section shall be included in the submittal.
 - 2. The Engineer of Record shall not be responsible for informing the contractor on items that have not been included and are necessary for a complete review of the required submittal information for a specification section.
 - 3. The Engineer of Record shall have the option of returning any submittal, unmarked, if all required documentation called for in the specifications has not been provided in the submittal.
 - 4. The Engineer of Record shall review each submittal no more than two (2) times and return to the contractor with the appropriate disposition.
 - 5. If the Engineer of Record is required to review a submittal a second time, it shall be limited to review of the changed information, clearly highlighted by the submitter, and/or confirmation of documentation only and it shall be returned to the contractor with the appropriate disposition.
 - 6. If the submittal is required to be reviewed a third time, it shall be done at the expense of the contractor. Charges for this additional submittal review shall be calculated based on the Engineer's standard hourly rates, as defined in their contract with the Owner.
- C. Operation and Maintenance Manuals: All items required for insertion into each Operation and Maintenance (O&M) Manual are called out in the submittals portion of each specification section or in a Submittal Log, if

included within Division 01. It is the responsibility of the Contractor to ensure that the O&M submittal has been reviewed and includes all the requirements of the specifications. The Engineer of Record shall review the submittal for the Operation and Maintenance Manual one (1) time and return to the contractor with the appropriate disposition.

1. If the submittal is required to be reviewed a second time, it shall be done at the expense of the contractor. Charges for this additional submittal review shall be calculated based on the Engineer's standard hourly rates, as defined in their contract with the Owner.
 2. Submittals for the Operation and Maintenance Manual must be original documentation.
 3. Photo copies of marked up Operations and Maintenance submittals are not acceptable.
- D. Refer to Division 01 and each individual Division 22 Section for additional submittal requirements.
- E. Prepare maintenance manuals in accordance with Division 01. In addition to the requirements specified in Division 01, 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.
 5. Facsimiles or photo copies are not allowed as submittals for operating and maintenance manuals. Submittals for operating and maintenance manuals must be on original manufacturer printed stock.
- F. Prepare and submit Coordination Drawings as further described herein. The Engineer shall receive one copy of all coordination drawings supplied to the Owner as required in this specification. It is the responsibility of the Contractor to coordinate the work as outlined herein. Receipt by the Engineer of a copy of the coordination drawings is to verify conformance to the submittal requirements set forth in this specification section. It is not an admission by the Engineer as to the accuracy or completeness of the coordination proposed.
- G. Coordination shall be drawn to a scale of $\frac{1}{4}" = 1'0"$ or larger. Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:
1. Planned piping layout, including valve and specialty locations and valve-stem movement. Include all piping including but not limited to Plumbing piping, HVAC piping, and fire protection piping. Include ceiling and wall-mounted access doors and panels required to provide access to valves and other operating devices.
 2. Planned ductwork layout, including terminal units, dampers and specialty locations, with terminal unit and damper operator clearances. Include ceiling and wall-mounted access doors and panels required to provide access to dampers and other operating devices.
 3. Clearances for installing and maintaining insulation.
 4. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
 5. Equipment and accessory service connections and support details.
 6. Exterior wall and foundation penetrations.
 7. Fire-rated wall and floor penetrations.
 8. Sizes and location of required concrete pads and bases.
 9. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
 10. Floor plans, elevations, and details to indicate penetrations in floors, walls, ceilings and roofs, and their relationship to other penetrations and installations.
 11. Ceiling plans showing coordination of mechanical, electrical, structural, ceiling suspension assembly, lighting, security, communications, fire alarm, plumbing, and fire protection work within allotted space.
 12. Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, access panels, special moldings, and other ceiling-mounted items.
 13. Floor plans and sections of fan rooms and mechanical rooms; show layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

- H. Prepare record documents in accordance with the requirements in Division 01. In addition to the requirements specified in Division 01, indicate the following installed conditions:
 - 1. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Indicate actual inverts and horizontal locations of all underground piping.
 - 2. Valve location diagrams, complete with valve tag chart. Refer to Division 220500 Section "Basic Plumbing Materials and Methods."
 - 3. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
 - 4. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
 - 5. Contract Modifications, actual equipment and materials installed.
 - 6. Invert elevation of underfloor sanitary and storm piping.
- I. Comply with each individual Division 22 Section for additional submittal requirements.
- J. Electronic Media and Files:
 - 1. Electronic media files of the contract drawings in AutoCAD or PDF format and copies of the specifications in PDF format may be requested.
 - 2. Complete and return a signed "Electronic File Transmittal" form provided by Ross & Baruzzini upon request for electronic media.
 - 3. Obtain approval from the appropriate Design Professional for use of their part of the documents if the information requested includes information prepared by other than Ross & Baruzzini.
 - 4. The electronic contract documents may be used for preparation of shop drawings and record drawings only. The information may not be used in whole or in part for any other project.
 - 5. The drawings prepared by Ross & Baruzzini for bidding purposes may not be used directly for raceway layout drawings or coordination drawings.
 - 6. The use of these documents does not allow relief from the responsibility for coordination of work with other trades and verification of space available for the installation.
 - 7. The information is provided to expedite the project with no guarantee by Ross & Baruzzini as to the accuracy or correctness of the information provided. Ross & Baruzzini accepts no responsibility or liability for the use of the provided information.

1.5 MATERIAL AND EQUIPMENT SELECTION

- A. Product Options: The specification of each item of major mechanical equipment required for the project may include a list of manufacturers, with one "basis of design" manufacturer, type, and model identified by virtue of their listing in the equipment schedule on the Drawings. Where several manufacturers in addition to the "basis of design" manufacturer are listed in the specifications, it shall be understood that the words "or approved equal by" are implied to precede each of the other manufacturer's names.
 - 1. The manufacturers other than the "basis of design" may be furnished at the contractor's option in lieu of the "basis of design" product, provided that the selected manufacturer's product is equal in all material and functional respects. In addition to submittal requirements that may be specified in this section, submit a line-by-line written verification of the applicable specification section(s) identifying compliance with or variations from the specified features, materials, performance, capacities, weight, size, durability, energy consumption and efficiency, warranty, and visual impact (if exposed to view by other than maintenance persons). The burden of proof of manufacturer/product equality is on the contractor.
 - 2. Where a product is not scheduled on the drawings and, therefore, where no "basis of design" is indicated, selection among all of the listed manufacturers and products is at the contractor's option, subject to the requirements of the Contract Documents.
 - 3. Products of manufacturers not listed in the Contract Documents are considered Substitutions and are not permitted, except as provided under the General and Supplementary Conditions and Division 01 Specifications. Full compliance with Division 01 section "Product Substitutions" is mandatory for acceptance of products or manufacturers not listed.
- B. Listing of a manufacturer does not imply approval of that manufacturer's standard product or products. Rather, listing of a manufacturer indicates only a general acceptance of that manufacturer's name and reputation. Final approval is subject to full compliance with these Contract Documents.
- C. Model numbers identified on the Drawings notwithstanding, all equipment must comply with the requirements of these Contract Documents. Do not assume that a manufacturer's standard product is acceptable as is. For example, one or more custom modifications, custom colors or finishes, manufacturer's options, and/or accessories may be required to meet the specified requirements.
- D. Where drawings indicate sizes, profiles, connections, and dimensional requirements of material and equipment, these are based on the "basis of design" manufacturer, type and model indicated. In the event that

equipment of power, dimensions, capacities, layout, connections, and/or ratings differing from the "basis of design" are selected by the contractor and approved by the Owner's representative, any necessary adjustments are the contractor's responsibility. All connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, pipe and duct sizes, pipe and duct layout, and the like shall be adjusted by the contractor to suit the equipment provided. No additional costs will be approved for these changes. Should revisions to the design because of contractor's selection of manufacturer, type, or model other than the "basis of design" require additional review and/or redesign by an Architect or Engineer, the contractor shall reimburse the Owner for Owner's added professional fee expenses.

- E. Where two or more materials are listed in the "Part 2 – Products" subsection of any Division 22 section, do not assume that the selection of materials is the contractor's option. Refer to "Part 3 – Execution" subsection of that same Division 22 section for an explanation of which specific material(s) shall be used for which specific application(s). For example, Part 2 may list several types and grades of piping, and Part 3 will describe which type and grade of pipe to use for a given application.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. Protect stored on-site or installed absorptive materials from moisture damage. Materials directly exposed to moisture via precipitation, water leaks, or condensation shall be removed from the jobsite and replaced.

END OF SECTION 220100

SECTION 22 0500 – BASIC PLUMBING MATERIALS AND METHODS

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.
- B. Section 200800 "Seismic Protection" and Section 220100 "Basic Plumbing Requirements" apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

- A. This Section includes the following basic plumbing materials and methods to complement other Division 22 Sections:
 - 1. Materials and installation instructions common to plumbing systems.
 - 2. Pipe joining materials and methods.
 - 3. Dielectric fittings.
 - 4. Pipe sleeves.
 - 5. Escutcheons.
 - 6. Penetration firestopping of fire-resistance-rated assemblies and/or smoke barriers by plumbing piping or conduit.
 - 7. Labeling and identifying plumbing systems and equipment.
 - 8. Non-shrink grout for equipment installations.
 - 9. Painting and finishing of plumbing work.
 - 10. Coordination with Structural work.
- B. Pipe and pipe fitting materials are specified in individual Division 22 piping system Sections.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following abbreviations are used throughout Division 22 Specification Sections:
 - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
 - 2. CPVC: Chlorinated polyvinyl chloride plastic.
 - 3. CR: Chlorosulfonated polyethylene synthetic rubber.
 - 4. EPDM: Ethylene propylene diene terpolymer rubber.
 - 5. NBR: Acrylonitrile-butadiene rubber.
 - 6. NP: Nylon plastic.
 - 7. PE: Polyethylene plastic.
 - 8. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

- A. Product Data: For dielectric fittings, transition couplings, flexible pipe connectors, plumbing sleeve seals, and identification materials and devices.
- B. For each type of penetration firestopping product, submit product data and include design designation of qualified testing and inspecting agency
- C. Shop Drawings: Detail fabrication and installation for supports and anchorage for plumbing materials and equipment.
- D. Coordination Drawings: For access panel and door locations.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify welding processes and operators for structural steel according to AWS D1.1 "Structural Welding Code – Steel."
- B. Welding: Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions of ASME B31 Series "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current.
 - 3. Contactor shall retain all welding certificates on file and produce them for review upon request by the Owner and/or Owner's representative.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and prevent entrance of dirt, debris, and moisture.
- B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor or roof, if stored thereupon.
- C. Protect flanges, fittings, and piping specialties from moisture and dirt.
- D. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.
- E. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

1.7 SEQUENCING AND SCHEDULING

- A. Coordinate plumbing equipment installation with other building components.
- B. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for plumbing installations.
- C. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.
- D. Sequence, coordinate, and integrate installations of plumbing materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.
- E. Coordinate connection of plumbing systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.
- F. Coordinate requirements for access panels and doors if plumbing items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Panels."
- G. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.
- H. Coordinate connection of electrical services.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Transition Couplings:
 - a. Dresser Industries, Inc.
 - b. or approved equal.
 - 2. Dielectric Fittings:
 - a. Precision Plumbing Products
 - 3. Identifying Devices and Labels:
 - a. Brady USA, Inc., Signmark Div.
 - b. Brimar Industries, Inc.
 - c. Kolbi Industries, Inc.
 - d. Panduit Corp.
 - e. Seton Name Plate Co.

2.2 PIPE AND PIPE FITTINGS

- A. Refer to individual Division 22 piping Sections for pipe and fitting materials and joining methods.

2.3 JOINING MATERIALS

- A. Refer to individual Division 22 piping Sections for joining materials.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.
- C. Pipe-Flange Joining Gaskets: ASME B16.21, EPDM, flat, asbestos-free, 1/8-inch (3.2-mm) thickness, unless noted otherwise.
 - 1. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - 2. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- D. Pipe-Flange Joining Bolts and Nuts: ASME B18.2.1 bolts with ASME B18.2.2 nuts, carbon steel, unless otherwise indicated.
 - 1. Bolts and nuts shall be Type 304 or Type 316 stainless steel, if installed on stainless steel piping, and matching the grade of stainless steel piping.
 - 2. Bolts and nuts shall be Type 304 stainless steel if installed on uninsulated piping located outdoors.
 - 3. Bolts and nuts shall be Type 316 stainless steel if installed on uninsulated direct-bury piping.
- E. Solder Filler Metals: ASTM B32 lead-free alloys. Include water-flushable flux according to ASTM B813.
- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- G. Solvent Cements: Manufacturer's standard solvent cements for the following:
 - 1. PVC Piping: ASTM D2564. Include primer according to ASTM F656.
- H. Plastic Pipe Seals: ASTM F477, elastomeric gasket.

2.4 DIELECTRIC FITTINGS

- A. Precision Plumbing Products Clearflow fittings shall be used wherever a dielectric fitting is needed.

2.5 PIPE SLEEVES

- A. The following sleeve materials are for wall, floor, slab, and roof penetrations.
- B. Steel Pipe: ASTM A53, Type E, Grade A, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.
- E. PE: Manufactured, reusable, tapered, cup shaped, smooth outer surface, with nailing flange for attaching to wooden forms.

2.6 ESCUTCHEONS

- A. General: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Stamped-Steel Type: With spring clips and chrome-plated finish.
- D. Split-Plate, Stamped-Steel Type: With concealed hinge, spring clips, and chrome-plated finish.
- E. One-Piece, Floor-Plate Type: Cast-iron floor plate.
- F. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.7 IDENTIFYING DEVICES AND LABELS

- A. General: Manufacturer's standard products of categories and types required for each application as referenced in other Division 22 Sections. If more than one type is specified for application, selection is installer's option, but provide one selection for each product category.
- B. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.
- C. Equipment Nameplates: Metal nameplate with operational data engraved or stamped; permanently fastened to equipment; furnished and factory-installed by original equipment manufacturer.
 - 1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data.

2. Location: Accessible and visible location.
- D. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, permanent adhesive, color-coded, pressure-sensitive vinyl, complying with ASME A13.1.
1. Nomenclature: Domestic Cold Water, Domestic Hot Water, Domestic Hot Water Return, Natural Gas, etc. as required per service. Match name to the name given on Drawings (full names, not abbreviations).
 2. Color: Per ASME A13.1 Standard per service, unless noted otherwise.
 3. Flow Direction: Indicate flow direction via arrows on each label.
- E. Engraved Plastic-Laminate Signs: ASTM D709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated.
1. Fabricate in sizes required for message.
 2. Engraved with engraver's standard letter style, of sizes and with wording to match equipment identification.
 3. Punch for mechanical fastening.
 4. Thickness: 1/16-inch (1.6 mm), for units up to 20 sq. in. (130 sq. cm) or 8 inches (200 mm) long; 1/8-inch (3.2 mm) for larger units.
 5. Fasteners: Self-tapping stainless-steel screws or contact-type permanent adhesive.
- F. Valve Tags: Photo-anodized barcode tags with 1/4-inch (6-mm) letters and numbers. Include 5/32-inch (4-mm) hole for fastener.
1. Material: 0.032-inch (0.8-mm) thick anodized aluminum.
 2. Color: Silver background with black characters.
 3. Printed Nomenclature: Piping system abbreviation and sequenced number; e.g., HW-23 for domestic hot water supply valve #23; HWR-12 for domestic hot water return valve #12.
 4. Barcode: Two-dimensional Data Matrix ECC 200 barcode symbology. Prior to manufacture, obtain valve tag information from owner's property manager for encoding into the barcode. Include valve number, piping system, system abbreviation, location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
- G. Valve Tag Fasteners: Brass, wire-link chain or stainless steel beaded chain.
- H. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in plumbing identification, with corresponding designations indicated. Use numbers, lettering, and wording indicated for proper identification and operation/maintenance of plumbing systems and equipment.
1. Multiple Systems: If multiple systems of same generic name are indicated, provide identification that indicates individual system number and service such as "Domestic Water Heater DWH1," "Hot Water Recirculation Pump HWRP1," or "Standpipe F12."

2.8 CONCRETE AND GROUT

- A. Concrete: For all minor concrete work required for plumbing installations, such as concrete equipment bases and supports, refer to Division 03 Sections for specification of cast-in-place concrete and reinforcing materials, whose requirements apply to the work of Division 22 as if fully reproduced herein.
- B. Concrete: For all minor concrete work required for plumbing installations, such as concrete equipment bases and supports, provide Quikrete® Commercial Grade FastSet™ Concrete #1004-51 prepackaged concrete mix, or approved equal. Mix, place, and cure in accordance with manufacturer's written instructions.
1. Reinforcing: ASTM A615 Grade 60 deformed bars and ASTM A185 welded wire fabric.
- C. Non-shrink, Nonmetallic Grout: ASTM C1107, Grade B.
1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 2. Design Mix: 5000-psig (34.5-MPa), 28-day compressive strength.
 3. Packaging: Premixed and factory packaged.

2.9 PAINTING AND FINISHING

- A. For all painting and finishing work required for plumbing installations, as described in Part 3 of this Section and/or on the Drawings, refer to Division 09 Sections for specification of paint and finishing materials, whose requirements apply to the work of Division 22 as if fully reproduced herein.
- B. Master Painters Institute, Inc. (MPI) Standards: Provide paint and paint products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."
- C. Material Compatibility: Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
- D. Colors: As directed by Owner's representative. Each pipe shall be painted a designated color according to service.

PART 3 - EXECUTION

3.1 GENERAL PLUMBING INSTALLATION REQUIREMENTS

- A. Verify all dimensions by field measurements.
- B. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
- C. 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.
- D. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
- E. Install plumbing 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. Extend grease fittings to an accessible location.
- F. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.2 PIPE-PENETRATION INSTALLATION REQUIREMENTS

- A. Install escutcheons for new piping penetrations of walls, ceilings, and floors according to the following:
 - 1. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - 2. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - 3. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - 4. Uninsulated Piping in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - 5. Uninsulated Piping in Unfinished Spaces: One-piece, cast-brass type.
 - 6. Uninsulated Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
- B. Install escutcheons for existing piping penetrations of new walls, ceilings, and floors. Match type, material, and finish as specified for new piping, except that split-casting or split-plate type will be accepted in lieu of one-piece.
- C. Install sleeves for pipes passing through concrete and masonry walls, and concrete floor and roof slabs.
- D. Cut sleeves to length for mounting flush with both surfaces. Exception: Extend sleeves installed in floors of mechanical/plumbing equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
- E. Fire-Resistance Rated, Cast-in-Place Sleeve Installation: Select sleeve size based on size and type of pipe and thickness of the floor. Position and secure sleeve to concrete form using nails or staples. Place concrete, and finish even with top of sleeve. Install in complete and strict accordance with manufacturer's UL-listed installation instructions.
- F. Build sleeves into new walls and slabs as work progresses.
- G. Install sleeves large enough to provide ¼-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - 1. Steel Pipe Sleeves: For pipes smaller than 6-inch NPS (DN150).
 - 2. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 07 Section "Flashing and Sheet Metal" for flashing.
 - 3. Seal space outside of sleeve fittings with non-shrink, nonmetallic grout.

- H. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using elastomeric joint sealants. Refer to Division 07 Section "Joint Sealants" for materials. Use Type S, Grade NS, Class 25, Use O, neutral-curing silicone sealant, unless otherwise indicated.
- I. Sleeves are not required for core-drilled holes.
- J. Permanent sleeves are not required for holes formed by PE removable sleeves.
- K. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestopping materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

3.3 EQUIPMENT INSTALLATION REQUIREMENTS

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- B. Refer to equipment specifications in Division 22 and Division 26 for rough-in requirements.
- C. Install equipment to provide maximum possible headroom, if mounting heights are not indicated.
- D. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to Architect.
- E. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- F. Positive attachment and anchorage of all equipment to the structure or floor is required. Do not rely on friction or gravity as a means of attachment.
- G. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- H. Install equipment giving right of way to piping installed at required slope.
- I. Install flexible pipe connectors at the following locations. Install on equipment side of shutoff valves.
 - 1. Inlet and outlet of each pump.
 - 2. Where indicated elsewhere in these specifications.
 - 3. Where detailed on the Drawings.
- J. Support for Suspended Equipment: As specified in Division 22 Section "Hangers and Supports."

3.4 LABELING AND IDENTIFYING

- A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow. Use plastic markers, with application systems. Install on insulation segment if required for hot, uninsulated piping.
- B. Locate pipe markers as follows if piping is exposed in finished spaces, machine rooms, and accessible maintenance spaces, such as shafts, tunnels, plenums, and exterior non-concealed locations:
 - 1. Near each valve and control device.
 - 2. Near each branch, excluding short takeoffs for fixtures and terminal units. Mark each pipe at branch, if flow pattern is not obvious.
 - 3. Near locations where pipes pass through walls, floors, ceilings, or enter non-accessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum of 50-foot (15-m) intervals along each run. Reduce intervals to 25 feet (7.5 m) in congested areas of piping and equipment.
 - 7. On piping above removable acoustical ceilings, except omit intermediately spaced markers.
- C. Install continuous plastic underground warning tapes during back filling of trenches for underground piping. Locate 6 to 8 inches (150 to 200 mm) below finished grade, directly over piping. Refer to Division 31 Section "Earth Moving" for warning-tape materials and devices and their installation.
- D. Equipment: Install engraved plastic-laminate sign on or near each major item of plumbing equipment.
 - 1. Lettering Size: Minimum ¼-inch- (6.4-mm-) high lettering for name of unit if viewing distance is less than 24 inches (610 mm), ½-inch- (12.7-mm-) high lettering for distances up to 72 inches (1800 mm), and proportionately larger lettering for greater distances. Provide secondary lettering two-thirds to three-fourths of size of principal lettering.
 - 2. Text of Signs: Provide name of identified unit. Include text to distinguish between multiple units, inform user of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
- E. Adjusting: Relocate identifying devices as necessary for unobstructed view in finished construction.

- F. Install valve tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, plumbing fixture supply stops, faucets, and similar roughing-in connections of end-use fixtures and units.

3.5 PAINTING AND FINISHING

- A. For all painting and finishing work required for plumbing installations, refer to Division 09 Sections for application requirements.
- B. Painting Plumbing Work: Paint the following work where exposed to view in finished or unfinished spaces: Uninsulated steel piping, pipe hangers and supports, tanks that do not have factory-applied final finishes, all interior and exterior ferrous piping and appurtenances, including steel, galvanized steel, cast iron and ductile iron.
- C. In addition, paint the following:
 - 1. Equipment, and pipe insulation having ASJ or other paintable jacket material.
- D. Steel Substrates: Primer, alkyd, anti-corrosive, for metal, MPI #79; plus topcoat of latex, interior, semi-gloss, MPI #54.
- E. Galvanized-Metal Substrates: Primer, galvanized, water based, MPI #134; plus topcoat of latex, interior, semi-gloss, MPI #54.
- F. Aluminum (Not Anodized or Otherwise Coated) Substrates: Primer, quick dry, for aluminum, MPI #95; plus topcoat of latex, interior, semi-gloss, MPI #54.
- G. ASJ Insulation-Covering Substrates: Including pipe and duct coverings. Primer sealer, latex, interior, MPI #50; plus topcoat of latex, interior, semi-gloss, MPI #54.
- H. Primers specified above may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

3.6 COORDINATION WITH STRUCTURAL WORK

- A. Concrete: Do not embed pipes, wires, tube, boxes, ducts or other cavity-creating elements in concrete work unless shown on or permitted by the structural drawings. Openings through concrete not shown on the structural drawings are subject to approval by the structural engineer of record. See coordination drawing requirements under Submittals.
- B. Roof Deck: Do not place loads on, or hang any loads whatsoever from roof deck, unless shown on structural drawings, including, but not limited to, hangers for pipes, ducts, equipment, etc. Trade contractor installing such loads shall provide sub-framing connected to steel frame.
 - 1. Do not exceed capacity of roof deck as a working platform. Submit all proposed construction loads to deck supplier for approval.
 - 2. Openings in roof deck not shown on structural drawings, such as openings required for stacks, pipes, ducts, plumbing vents, etc., shall be cut and reinforced by trade requiring opening.
- C. Supported Slab: Do not suspend loads exceeding 500 pounds within any 100 square feet of contiguous area from concrete supported slab. Suspend such loads from structural steel only. Any "sub-framing" required is responsibility of Contractor or sub-contractor installing material requiring support.
 - 1. Openings in concrete floor slabs not shown on structural drawings, such as openings required for stacks, pipes, ducts, plumbing vents, etc., shall be the responsibility of the trade requiring openings. Form block-outs in the slab, reinforcing deck, and cut openings after concrete has reached specified strength.
 - 2. Where openings larger than 12-inches are required but not shown on structural drawings, secure written approval from Architect/Engineer prior to cutting deck.

3.7 ERECTION OF SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- B. Field Welding: Comply with AWS D1.1, "Structural Welding Code – Steel."

3.8 GROUTING

- A. Install nonmetallic, non-shrink, grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Mix grout according to manufacturer's written instructions. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.

- D. Place grout, completely filling equipment bases. Avoid air entrapment during placing of grout. Place grout on concrete bases to provide smooth bearing surface for equipment. Place grout around anchors.
- E. Cure placed grout according to manufacturer's written instructions.

END OF SECTION 220500

SECTION 22 0523 – VALVES

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.
- B. Section 200800 "Seismic Protection," Section 220100 "Basic Plumbing Requirements," and Section 220500 "Basic Plumbing Materials and Methods" all apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

- A. This Section includes the following general-duty valves common to Division 22 plumbing piping systems:
 - 1. Ball valves.
 - 2. Butterfly valves.
 - 3. Check valves.
- B. Related Sections include the following:
 - 1. Division 22 piping Sections for general-duty and specialty valves for site construction piping.
 - 2. Division 22 Section "Plumbing Identification" for valve tags and charts.
 - 3. Division 22 Section "Basic Plumbing Materials and Methods" for valve tags and charts.
 - 4. Division 22 piping Sections for specialty valves applicable to those Sections only.
 - 5. Valves - natural gas service, medical gases, fire protection, and other specialty services are specified in their respective piping Section.

1.3 DEFINITIONS

- A. The following are standard abbreviations for valves used in this Section:
 - 1. CWP: Cold working pressure (formerly WOG – Water, Oil, Gas working pressure).
 - 2. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 3. IBBM: Iron body, bronze-mounted.
 - 4. PTFE: Polytetrafluoroethylene plastic.
 - 5. SWP: Steam working pressure.
 - 6. TFE: Tetrafluoroethylene plastic.
 - 7. Class 125: Minimum 125-psig (860-kPa) SWP and minimum 200-psig (1380-kPa) CWP ratings.
 - 8. Class 150: Minimum 150-psig (1035-kPa) SWP and minimum 300-psig (2070-kPa) CWP ratings.

1.4 SUBMITTALS

- A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.
- B. Maintenance Data: For each type of valve, to include in the operation and maintenance manual specified in Division 01. Include detailed manufacturer's instructions on adjusting, servicing, disassembling, and repairing.

1.5 QUALITY ASSURANCE

- C. ASME Compliance: ASME B31.9 for building services piping valves.
- D. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.
- E. NSF Compliance: NSF 61 for valve materials for potable-water service in compliance with Public Law #111-380.
- F. MSS Compliance: Comply with the various MSS Standard Practice documents referenced herein.

1.6 DELIVERY, STORAGE, AND HANDLING

- G. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.

2. Protect threads, flange faces, grooves, and weld ends.
 3. Set ball valves open to minimize exposure of functional surfaces.
 4. Set butterfly valves closed or slightly open.
 5. Block check valves in either closed or open position.
- H. Use the following precautions during storage:
1. Maintain valve end protection.
 2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- I. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. General: Subject to compliance with requirements, provide gate valves, globe valves, and swing check valves by one of the following:
1. Apollo.
 2. Hammond Valve.
 3. Milwaukee Valve Company.
 4. NIBCO Inc.
 5. Watts Industries, Inc.; Water Products Div.
- B. Ball Valves: Subject to compliance with requirements, provide ball valves by one of the following:
1. Any of the manufacturers listed under the "General" subheading above.
- C. Standard-Performance Butterfly Valves: Subject to compliance with requirements, provide butterfly valves by one of the following:
1. Any of the manufacturers listed under the "General" subheading above.
- D. Swing, piston and Wafer Check Valves: Subject to compliance with requirements, provide butterfly-style dual-plate wafer check valves, piston-style lift-disc, and swing check valves by one of the following:
1. Any of the manufacturers listed under the "General" subheading above.

2.2 VALVES, COMMON REQUIREMENTS

- A. General: Refer to Part 3 "Valve Applications Schedule" Article for application schedule of valves, end connections, and actuator types.
- B. Valve Sizes: Same as upstream pipe size, unless otherwise indicated.
- C. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.
- D. Valve Grooved Ends: AWWA C606.
- E. Valve Threaded Ends: With threads according to ASME B1.20.1.
- F. Valve Bypass and Drain Connections: MSS SP-45.
- G. Material Substitution: Ductile iron is acceptable anywhere cast iron is specified, but cast iron is not acceptable where ductile iron is specified.
- H. Class Substitution: If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.
- I. For piping systems required to be insulated, valve stems shall be extended to accommodate insulation. Refer to other Division 22 Sections for piping systems required to be insulated.
- K. NSF Compliance: NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.
- L. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- M. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

2.3 BALL VALVES

- A. Liquid Service, Size NPS 2-1/2 and smaller:
1. General: Valve shall conform to MSS SP-110.

2. Minimum SWP rating: 150-psig (1035-kPa).
3. Minimum CWP rating: 600-psig (4140-kPa).
4. Body: ASTM B584 bronze, two-piece construction.
5. Ball: Type 316 stainless steel, full port.
6. Stem: Blowout-proof Type 316 stainless steel.
7. Seat/Packing: PTFE or TFE.
8. Ends: Threaded/Soldered.
9. Handle: Vinyl-covered steel lever with memory stop; and zinc-plated steel nut.

2.4 STANDARD-PERFORMANCE BUTTERFLY VALVES

- A. General: Valve shall conform to MSS SP-67, Type I.
- B. Minimum CWP rating: 175-psig (1207-kPa).
- C. Body and bonnet: ASTM A536 ductile-iron, extended neck. Cast iron valves will be rejected.
- D. Packing: Field-replaceable EPDM sleeve and stem seals.
- E. Stem and Stem Hardware: Type 316 or 416 stainless steel.
- F. Disc: Aluminum bronze or Type 316 stainless steel.
- G. End Connections: Lug and flanged bodies are acceptable; wafer bodies are not acceptable. Grooved-end valve bodies are acceptable wherever grooved-end piping is permitted; refer to other Division 22 Sections for permitted applications of grooved-end piping.
- H. Dead End Service: All butterfly valves shall be suitable for bi-directional dead-end service without downstream blind flange. Bolt holes on lugged valve bodies shall be threaded per ANSI B-1.1 coarse thread, with center stop, to accept cap screws from both directions.
- I. Operator: Lever handle with ten-position latching mechanism, except where noted below.

2.5 CHECK VALVES

- A. Bronze Swing Check Valve, NPS 2 (DN50) and smaller: Valve shall conform to MSS SP-80.
 1. Minimum pressure rating: Class 150.
 2. Body: ASTM B62 bronze body, y-pattern.
 3. Bonnet: ASTM B62 bronze, threaded, removable for regrinding.
 4. Disc and seat: Renewable; ASTM B62 bronze with bronze-alloy hinge pin.
 5. Hardware: Bronze or bronze alloy.
 6. Ends: Threaded.
- B. Cast-Iron Swing Check Valves, NPS 2½ (DN65) and larger: Valve shall conform to MSS SP-71, Type I.
 1. Minimum pressure rating: Class 125.
 2. Body: ASTM A126 Cl. B cast-iron body and bronze-mounted (IBBM).
 3. Bonnet: ASTM A126 Cl. B cast-iron, bolted to body with steel bolts.
 4. Disc and seat: Renewable; Ductile-iron or bronze-alloy.
 5. Ends: Flanged.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- D. Examine threads on valve and mating pipe for form and cleanliness.
- E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves as indicated, according to manufacturer's written instructions.

- B. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- C. Install isolation valves at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- D. Locate valves for easy access and provide separate support where necessary.
- E. Install valves in horizontal piping with stem at or above center of pipe.
- F. Any valve that represents a termination or the end of a run (e.g., blowdown or drain valve, hose-end valve, etc.) shall be fitted with a permanent but removable cap, plug, or blind flange matching the valve construction, to minimize risk in the event the valve is accidentally opened under pressure.
- G. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level, or vertical with upward flow.

3.3 JOINT CONSTRUCTION

- A. Refer to Division 22 Section "Basic Plumbing Materials and Methods" for basic piping joint construction.
- B. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.
- C. Threaded Connections: Note the internal length of threads in valve ends and proximity of valve internal seat or wall to determine how far pipe should be threaded into valve.
 - 1. Align threads at point of assembly.
 - 2. Apply appropriate tape or thread compound to the external pipe threads, except where dry seal threading is specified.
 - 3. Assemble joint, wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.
- D. Flanged Connections: Align flange surfaces parallel.
 - 1. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.
 - 2. For dead-end service, butterfly valves require flanges both upstream and downstream for proper shutoff and retention.

3.4 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.5 VALVE APPLICATIONS SCHEDULE

- A. General: Refer to piping Sections and Drawings for specific valve applications. If no specific valve type is indicated, use the valve types indicated in the following schedules.
- B. Domestic Water Piping: Choices are contractor's option unless a specific type of valve is specifically called out by name on the Drawings.
 - 1. For shutoff duty, NPS 2 (DN 50) and smaller, use ball valves.
 - 2. For shutoff duty, NPS 2½ (DN 65) and larger, use butterfly valves.
 - 3. For pump discharge protection, NPS 2 (DN 50) and smaller, use swing check valves.
 - 4. For one-way flow control other than at pump discharge, use swing check valves in all sizes.

END OF SECTION 220523

SECTION 22 0529 – PLUMBING HANGERS AND SUPPORTS

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.
- B. Section 200800 "Seismic Protection," Section 220100 "Basic Plumbing Requirements," and Section 220500 "Basic Plumbing Materials and Methods" all apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

- A. This Section includes hangers and supports for mechanical system piping and equipment, including but not limited to the following:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Thermal-hanger shield inserts.
 - 4. Fastener systems.
- B. Related Sections include the following:
 - 1. Division 05 Sections for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports; and for materials for attaching hangers and supports to building structure.
 - 2. Division 20 Section "Seismic Protection" for seismic restraint requirements.
 - 3. Division 22 Section "Pipe Expansion Fittings" for pipe guides and anchors.
 - 4. Division 22 Section "Plumbing Vibration Isolation" for vibration isolation devices.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

- A. If contractor elects to apply channel support systems and/or heavy-duty steel trapezes to support multiple pipes, in lieu of individual supports, then contractor is responsible for design of same capable of supporting combined weight of supported systems, system contents, and test water.
 - 1. Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Do not suspend pipe hangers and supports from roof deck. Suspend such loads from structural steel only, and provide structural steel sub-framing as required.
- C. Do not suspend piping loads exceeding 500 pounds within any 100 square feet of contiguous area from supported concrete floor slabs. Suspend such loads from structural members only, and provide structural steel sub-framing as required.
- D. Structural Performance: Hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1.5 SUBMITTALS

- A. Product Data: For each type of pipe hanger, channel support system component, and thermal-hanger shield insert indicated. Include:
 - 1. Metal pipe hangers and supports.
 - 2. Thermal-hanger shield inserts.
 - 3. Fastener systems.
 - 4. Trapeze pipe hangers. Include Product Data for components.
- B. Shop Drawings: Signed and sealed shop drawings by a qualified professional engineer are required for all custom pipe and equipment hangers and supports. Show fabrication and installation details and analysis data, and include calculations.
- C. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code – Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Manufactured Pipe Hangers:
 - a. Anvil International, Inc.
 - b. Cooper B-Line, Inc.
 - c. Carpenter & Patterson, Inc.
 - d. Erico International Corp.
 - e. PHD Manufacturing, Inc.
 - f. Tolco division of Cooper B-Line, Inc.
 - 2. Thermal-Hanger Shield Inserts:
 - a. Carpenter & Paterson, Inc.
 - b. Erico International Corp.
 - c. PHS Industries, Inc.
 - d. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
 - 3. Powder-Actuated Fastener Systems:
 - a. Hilti, Inc.
 - b. ITW Ramset/Red Head.
 - c. Simpson Manufacturing Co.; Strong-Tie Anchor Systems Div.

2.2 METAL PIPE HANGERS AND SUPPORTS

- A. Application: Refer to "Hanger and Support Applications" Article in Part 3 for where to use specific hanger and support types.
- B. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
 - 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
 - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel unless noted otherwise.
- C. Stainless-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel unless noted otherwise.

2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 THERMAL-HANGER SHIELD INSERTS

- A. Insulation-Insert Material for Piping Below Ambient Temperature: ASTM C552, Type II cellular glass with 100-psig (688-kPa) or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength and vapor barrier.
- B. Insulation-Insert Material for Piping At or Above Ambient Temperature: Water-repellent treated, ASTM C533, Type I calcium silicate with 100-psig (688-kPa) ASTM C552, Type II cellular glass with 100-

psig (688-kPa) or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength.

- C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- E. Insert Length: Extend 2-inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless- steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 MISCELLANEOUS MATERIALS

- A. Structural and Miscellaneous Steel: As specified in Division 22 Section "Basic Plumbing Materials and Methods."
- B. Grout: As specified in Division 22 Section "Basic Plumbing Materials and Methods."

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT SCHEDULE OF APPLICATIONS

- A. Comply with MSS SP-69 for pipe hanger and trapeze selections and applications that are not specified in this Section.
- B. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use copper-plated pipe hangers and copper or stainless-steel attachments, or use nonmetallic coatings on attachments for electrolytic protection, where hangers are in direct contact with copper tubing.
- E. Horizontal-Piping Hangers and Supports for individual, insulated pipe runs which are both 2½-inch diameter or larger and 20 feet or longer: Unless otherwise indicated, choose among the following types:
 - 1. Single Pipe Rolls (MSS Type 41): For suspension of pipes from two rods.
 - 2. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes from single rod.
 - 3. Complete Pipe Rolls (MSS Type 44): Where vertical adjustment is not necessary.
 - 4. Adjustable Pipe Roll and Base Units (MSS Type 46): For vertical and lateral adjustment.
 - 5. For any of the above, include protection saddles and/or shields as applicable, and as further specified under the heading "Protection of Insulated Piping" elsewhere in this section.
 - 6. Exception: Piping whose normal operating temperature is less than 150°F (e.g., chilled water, condenser water) may be supported with static hangers specified in the next paragraph.
- F. Horizontal-Piping Hangers and Supports for individual pipe runs less than 20 feet long and all piping 2-inch diameter or smaller, regardless of length: Unless otherwise indicated, choose among the following types:
 - 1. Adjustable Steel Clevis Hangers (MSS Type 1).
- G. Horizontal-Piping Hangers and Supports for individual uninsulated pipe runs of any size or length: Unless otherwise indicated, choose among the following types:
 - 1. Adjustable Steel Clevis Hangers (MSS Type 1).
 - 2. Adjustable Steel Band Hangers (MSS Type 7): For pipes up to NPS 2 only.
 - 3. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For pipes up to NPS 2 only.
- H. Vertical-Piping Hangers and Supports for individual, insulated pipe runs which are both 2½-inch diameter or larger and 20 feet or longer: Use spring hangers and supports. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports shall include the following types:
 - 1. Horizontal (MSS Type 54): Mounted horizontally.
 - 2. Vertical (MSS Type 55): Mounted vertically.
 - 3. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- I. Vertical-Piping Hangers and Supports for individual pipe runs less than 20 feet long and all piping 2-inch diameter or smaller, regardless of length: Unless otherwise indicated, choose among the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8).

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): Where longer ends are required.
- J. Vertical-Piping Hangers and Supports for individual uninsulated pipe runs of any size or length: Unless otherwise indicated, choose among the following types:
 1. Extension Pipe or Riser Clamps (MSS Type 8).
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): Where longer ends are required.
- K. Hanger-Rod Attachments: Unless otherwise indicated, choose among the following types:
 1. Steel Turnbuckles (MSS Type 13).
 2. Steel Clevises (MSS Type 14).
 3. Malleable-Iron Sockets (MSS Type 16).
 4. Steel Weldless Eye Nuts (MSS Type 17).
- L. Building Attachments: Unless otherwise indicated, choose among the following types:
 1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to concrete ceiling.
 2. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 3. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams.
 4. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 5. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 6. Side-Beam Brackets (MSS Type 34): For sides of steel beams.
 7. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

3.2 HANGER AND SUPPORT MAXIMUM SPACING AND MINIMUM ROD SIZE

- A. Install hangers and supports with the following maximum spacing and minimum rod sizes.
- B. Flanged, Threaded, or Welded Steel Piping for Natural Gas piping systems:
 1. NPS ½ (DN 15): Maximum span, 5 feet (1.5 m); minimum rod size, 3/8-inch (10 mm).
 2. NPS ¾ (DN 20): Maximum span, 7 feet (2.1 m); minimum rod size, 3/8-inch (10 mm).
 3. NPS 1 (DN 25): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8-inch (10 mm).
 4. NPS 1¼ (DN 32): Maximum span, 9 feet (2.7 m); minimum rod size, 3/8-inch (10 mm).
 5. NPS 1½ (DN 40): Maximum span, 9 feet (2.7 m); minimum rod size, 3/8-inch (10 mm).
 6. NPS 2 (DN 50): Maximum span, 9 feet (2.7 m); minimum rod size, 3/8-inch (10 mm).
 7. NPS 2½ (DN 65): Maximum span, 10 feet (3 m); minimum rod size, 1/2-inch (13 mm).
 8. NPS 3 (DN 80): Maximum span, 10 feet (3 m); minimum rod size, 1/2-inch (13 mm).
 9. NPS 4 (DN 100): Maximum span, 10 feet (3 m); minimum rod size, 5/8-inch (16 mm).
- C. Drawn-Temper Copper Piping for any liquid-service piping systems:
 1. NPS ½ (DN 15): Maximum span, 4 feet (1.2 m); minimum rod size, 3/8-inch (10 mm).
 2. NPS ¾ (DN 20): Maximum span, 5 feet (1.5 m); minimum rod size, 3/8-inch (10 mm).
 3. NPS 1 (DN 25): Maximum span, 6 feet (1.8 m); minimum rod size, 3/8-inch (10 mm).
 4. NPS 1¼ (DN 32): Maximum span, 6 feet (1.8 m); minimum rod size, 3/8-inch (10 mm).
 5. NPS 1½ (DN 40): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8-inch (10 mm).
 6. NPS 2 (DN 50): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8-inch (10 mm).
 7. NPS 2½ (DN 65): Maximum span, 9 feet (2.7 m); minimum rod size, 1/2-inch (13 mm).
 8. NPS 3 (DN 80): Maximum span, 10 feet (3 m); minimum rod size, 1/2-inch (13 mm).
 9. NPS 4 (DN 100): Maximum span, 12 feet (3.7 m); minimum rod size, 5/8-inch (16 mm).
- D. Polypropylene, CPVC and PVC Piping for any service:
 1. NPS ½ (DN 15): Maximum span, 3 feet (0.9 m); minimum rod size, 3/8-inch (10 mm).
 2. NPS ¾ (DN 20): Maximum span, 3 feet (0.9 m); minimum rod size, 3/8-inch (10 mm).
 3. NPS 1 (DN 25): Maximum span, 3 feet (0.9 m); minimum rod size, 3/8-inch (10 mm).
 4. NPS 1¼ (DN 32): Maximum span, 4 feet (1.2 m); minimum rod size, 3/8-inch (10 mm).
 5. NPS 1½ (DN 40): Maximum span, 4 feet (1.2 m); minimum rod size, 3/8-inch (10 mm).
 6. NPS 2 (DN 50): Maximum span, 4 feet (1.2 m); minimum rod size, 3/8-inch (10 mm).
 7. NPS 2½ (DN 65): Maximum span, 4 feet (1.2 m); minimum rod size, 1/2-inch (13 mm).
 8. NPS 3 (DN 80): Maximum span, 4 feet (1.2 m); minimum rod size, 1/2-inch (13 mm).

9. NPS 4 (DN 100): Maximum span, 4 feet (1.2 m); minimum rod size, 5/8-inch (16 mm).
 10. NPS 6 (DN 150): Maximum span, 4 feet (1.2 m); minimum rod size, 3/4-inch (19 mm).
 11. NPS 8 (DN 200): Maximum span, 4 feet (1.2 m); minimum rod size, 7/8-inch (22 mm).
- E. Support vertical runs at roof, at each floor, and at 10-foot (3-m) intervals between floors.
- F. Rod diameters may be reduced one size for double-rod hangers, with 3/8-inch (10 mm) minimum rods.
- G. Hanger and support spacing for piping and tubing not listed above shall be according to MSS SP-69 and piping manufacturer's written instructions.

3.3 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 2. Field fabricate from ASTM A36/A36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- D. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- E. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- F. Install lateral bracing with pipe hangers and supports to prevent swaying.
- G. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- H. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2½ (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- J. Repair any building insulation or building fireproofing materials, whether new or existing, that are removed or scraped away in order to attach hangers and supports, so as to maintain an equivalent insulation or fire rating as existed without said hanger or support attachment.
- K. Fastener System Installation:
1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4-inches (100 mm) thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

3.4 PROTECTION OF INSULATED PIPING:

- A. Attach clamps and spacers to piping.
1. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 2. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
- B. Do not exceed pipe stress limits according to ASME B31.9.
- C. Piping Operating above Ambient Air Temperature: Clevis- and clamp-type supports shall project through insulation, with pipe support making direct contact with pipe and with insulation applied in a manner that encapsulates the clevis or clamp. For piping on roller-type supports, install MSS SP-58, Type 39 protection saddles, and fill interior voids with insulation that matches adjoining insulation.
1. Contractor's Option: In lieu of the above paragraph, contractor has the option of complying with the same specifications as for "Piping Operating below Ambient Air Temperature" in the following paragraphs.

- D. Piping Operating below Ambient Air Temperature: Clevis- and clamp-type supports shall be sized for the outside diameter of the insulation including jacket. Install MSS SP-58, Type 40 protective metal shields. Shields shall span an arc of 180 degrees.
1. Pipe Sizes NPS 4 and larger: Include thermal-hanger shield inserts. Insert shall be same thickness as adjoining pipe insulation and length shall be at least as long as the protective shield. Include steel weight-distribution plate if pipe is installed on rollers.
 2. Metal Shield Dimensions for Pipe: Not less than the following:
 - a. NPS ¼ to NPS 3½: 12-inches long and 0.048-inch thick.
 - b. NPS 4: 12-inches long and 0.06-inch thick.
 - c. NPS 5 and NPS 6: 18-inches long and 0.06-inch thick.
 - d. NPS 8 to NPS 12 (DN 200 to DN 350): 24-inches (610 mm) long and 0.075-inch (1.91 mm) thick.

3.5 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.6 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1½-inches (40 mm).

3.7 PAINTING

- A. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.
- B. 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. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).
- C. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

END OF SECTION 220529

SECTION 22 0700 -PLUMBING PIPE INSULATION

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.
- B. Section 20 0800 "Seismic Protection," Section 22 01 00 "Basic Plumbing Requirements," and Section 22 0500 "Basic Plumbing Materials and Methods" all apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

- A. This Section includes plumbing insulation for, equipment, piping, and other installations, including the following:
 - 1. Insulation Materials:
 - a. Flexible elastomeric.
 - 2. Adhesives.
 - 3. Sealants.
 - 4. Field-applied jackets.
 - 5. Tapes.
 - 6. Protective shielding guards.
- B. Related Sections include the following:

1.3 DEFINITIONS

- A. ASJ: All-service jacket.
- B. FSK: Foil, scrim, kraft paper.
- C. SSL: Self-sealing lap.
- D. Thermal Resistivity: "R-values" represent the reciprocal of thermal conductivity (k-value). Thermal conductivity is the rate of heat flow through a homogenous material exactly 1-inch thick. Thermal resistivities are expressed by the temperature difference in degrees F between two exposed faces required to cause one BTU to flow through one square foot of material, in one hour, at a given mean temperature.
- E. Refer to Division 22 Section "Basic Plumbing Materials and Methods" for definitions of finished, interior, exterior, exposed, and concealed locations.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated, identify thermal conductivity, thickness, and jackets (both factory and field applied, if any).

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: Insulation and related materials shall have flame-spread index of 25 or less, and smoke-developed index of 50 or less, as determined by testing identical products per ASTM E84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports."
- B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
 - 1. Flexible Elastomeric Insulation:
 - a. Aeroflex USA Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. K-Flex USA; Insul-Lock® Seam-Seal.
 - d. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.
 - 2. Sealants, Adhesives and Mastics: Same as insulation manufacturer, or
 - a. Childers Products, Division of ITW.
 - b. Foster Products Corporation, H. B. Fuller Company.
 - c. ITW TACC, Division of Illinois Tool Works.
 - d. Marathon Industries, Inc.
 - e. Mon-Eco Industries, Inc.
 - f. Vimasco Corporation.
 - 3. Field-Applied Jackets: Same as insulation manufacturer, or
 - a. Childers Products, Division of ITW.
 - b. P.I.C. Plastics, Inc.
 - c. PABCO Metals Corporation.
 - d. Pittsburgh Corning Corporation.
 - e. Polyguard.
 - f. Proto PVC Corporation.
 - g. RPR Products, Inc.
 - h. Speedline Corporation.
 - 4. Tapes: Same as insulation manufacturer, or
 - a. Avery Dennison Corporation, Specialty Tapes Division.
 - b. Compac Corp.
 - c. Ideal Tape Co., Inc., an American Biltrite Company.
 - d. Venture Tape.
 - 5. Insulation Pins and Hangers: Same as insulation manufacturer, or
 - a. AGM Industries, Inc.
 - b. GEMCO.
 - c. Midwest Fasteners, Inc.
 - d. Nelson Stud Welding.

2.2 INSULATION MATERIALS

- A. Refer to Schedule in Part 3 for requirements about where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Adhesives shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

- G. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534, Type I for tubular materials and Type II for sheet materials.
 - 1. Thermal Conductivity: 0.27 average maximum at 100°F mean temperature.
 - 2. Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 3. Low-emitting (VOC) adhesive.

2.3 SEALANTS

- 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Joint Sealants:
- 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Permanently flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 100 to plus 300°F (Minus 73 to plus 149 C).
 - 4. Color: White or gray.

2.4 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 - 1. Adhesive: Compatible with PVC, as recommended by jacket material manufacturer.
 - 2. Color: White.
 - 3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - 4. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
 - 5. Factory-fabricated tank heads and tank side panels.

2.5 TAPES

- A. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
 - 1. Width: 2-inches (50 mm).
 - 2. Thickness: 6 mils (0.15 mm).
 - 3. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
 - 4. Elongation: 500 percent.
 - 5. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

2.6 PROTECTIVE SHIELDING GUARDS

- A. Protective Shielding Pipe Covers.
 - 1. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.
 - 2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold- water supplies and trap and drain plumbing. Comply with ADA requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
 - 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
 - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

3.3 COMMON INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, fittings, and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4-inches (100 mm) o.c.
 - 3. Overlap jacket longitudinal seams at least 1½-inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2-inches (50 mm) o.c.
 - 4. For below ambient services, apply vapor-barrier mastic over staples.
 - 5. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 - 6. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4-inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. At the following locations, omit jacket and provide a separate cutaway removable segment of insulation clearly labeled "Access." For below-ambient services, provide a design that allows access but maintains vapor barrier.
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Manholes.
 - 5. Handholes.

6. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2-inches (50 mm) below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2-inches (50 mm).
 4. Seal jacket to wall flashing with flashing sealant.
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- D. Insulation Installation at Fire-Rated Wall and Partition Penetrations:
 1. Install pipe insulation continuously through pipe penetrations of fire-rated walls and partitions.
 2. Firestopping and fire-resistive joint sealers are specified in Division 07 Section "Penetration Firestopping."
- E. Insulation Installation at Floor Penetrations:
 1. Pipe: Install insulation continuously through floor penetrations.
 2. Seal penetrations through fire-rated assemblies according to Division 07 Section "Penetration Firestopping."

3.5 PIPE INSULATION INSTALLATION

- A. Requirements in this Article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Straight Pipes and Tubes:
 1. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. If furnished in half sections, orient longitudinal joints at 3 and 9 o'clock positions on the pipe.
 2. All insulation shall be tightly butted and free of voids and gaps at all joints.
 3. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 4. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6-inches (150 mm) o.c.
 5. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant. Vapor barrier must be continuous.
- C. Insulation Installation on Pipe Flanges:
 1. Install preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation, not to exceed 1½-inch (38-mm) thickness.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same thickness as pipe insulation.
 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1-inch (25 mm), and seal joints with flashing sealant.

- D. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
 3. Cut sectional pipe insulation to fit. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
- E. Insulation Installation on Valves, Strainers, Unions, and Specials:
1. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation over valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 4. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 5. Insulate unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 6. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 7. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 8. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- F. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- G. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2-inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

- H. Special Requirements for Flexible Elastomeric Insulation Installation: Seal all transverse seams, longitudinal seams, end joints, and section joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.6 FIELD-APPLIED JACKET INSTALLATION

- A. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- B. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12-inches (300 mm) o.c. and at end joints.

3.7 FINISHES

- A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

3.8 PIPING INSULATION SCHEDULE, GENERAL

- A. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 1. Fire-suppression piping.
 2. Drainage (sanitary/waste) piping located in crawl spaces.
 3. Below-grade piping.
 4. Chrome-plated pipes and fittings unless there is a potential for personnel injury.
- B. Hot Surfaces: For piping services denoted all piping surfaces including but not limited to pipe, flanges, fittings, valves of every kind, strainers, unions, and other appurtenances shall be insulated to avoid potential for personnel injury via contact with hot surface.
- C. Cold Surfaces: For piping surfaces operating below surrounding ambient temperature, all piping surfaces including but not limited to pipe, flanges, fittings, valves of every kind, strainers, unions, and other appurtenances shall be insulated and shall include uninterrupted vapor barrier to avoid potential condensation.

3.9 PIPE INSULATION SCHEDULE, INDOORS

- A. Domestic Cold Water:
 1. Insulation shall be any of the following:
 - a. Flexible Elastomeric: 1-inch (25 mm) thick.
- B. Domestic Hot-Water Supply and Return, 140°F and below:
 1. NPS 1¼ and Smaller: Insulation shall be Flexible Elastomeric, 1-inch thick.
 2. NPS 1½ (DN 40) and Larger: Insulation shall be Flexible Elastomeric, 1-1/2 inches thick.
- C. Domestic Water Branch Piping to Fixtures within Walls/Chases (Hot and Cold; Non-Recirculated):
 1. NPS 2 and smaller: Insulation shall be flexible elastomeric, 1/2 inch thick.
- D. Storm Piping (including drain body and overflow storm piping)
 1. NPS-ALL: Insulation shall be flexible elastomeric, 1" thick.

3.10 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over all mineral-fiber or fiberglass insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. Except as noted below, apply the following field jackets on all mineral-fiber or fiberglass insulation:
 1. Equipment: Aluminum, Stucco Embossed, 0.016-inch (0.41 mm) thick.
 2. Piping: PVC, 30 mils (0.8 mm) thick.

- C. Exceptions: Field jackets are not required over insulation in the following cases:
1. If equipment, piping, are concealed above a ceiling or in an enclosed shaft, chase or walls.
 2. If equipment, piping, are installed 96-inches or greater above floor.
 3. If equipment, piping, handle a service with a normal operating temperature 60°F (16°C) or higher.
Except when exposed to view less than 96" above floor.

END OF SECTION 220700

SECTION 22 1116 - DOMESTIC WATER PIPING

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.
- B. Section 200800 "Seismic Protection," Section 220100 "Basic Plumbing Requirements," and Section 220500 "Basic Plumbing Materials and Methods" all apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

- A. Section Includes:
 - 1. Copper tube and fittings.
 - 2. Ductile-iron pipe and fittings.
 - 3. Piping joining materials.
 - 4. Dielectric fittings.

1.3 ACTION SUBMITTALS

- A. Product Data: For transition fittings and dielectric fittings.

1.4 INFORMATIONAL SUBMITTALS

- A. System purging and disinfecting activities report.
- B. Field quality-control reports.

1.5 FIELD CONDITIONS

- A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
 - 1. Notify Construction Manager and Owner no fewer than fourteen days in advance of proposed interruption of water service.
 - 2. Do not interrupt water service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
- B. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with "NSF-pw."
- C. Comply with NSF Standard 372 for low lead.

2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
- B. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- C. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- D. Copper Unions:
 - 1. Solder-joint or threaded ends.

2.3 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials:
 - 1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
 - 2. Full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys.
- D. Flux: ASTM B 813, water flushable.

2.4 DIELECTRIC FITTINGS

- A. See Section 220500 "Basic Plumbing Materials and Methods".

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 221119 "Domestic Water Piping Specialties."
- D. Install shutoff valve immediately upstream of each dielectric fitting.
- E. Install domestic water piping level without pitch and plumb.
- F. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices in Section 200800 "Seismic Protection."
- G. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- H. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- I. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- J. Install piping to permit valve servicing.
- K. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- L. Install piping free of sags and bends.
- M. Install fittings for changes in direction and branch connections.
- N. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220500 "Basic Plumbing Materials and Methods."
- P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220500 "Basic Plumbing Materials and Methods." Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220500 "Basic Plumbing Materials and Methods."

3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- D. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.4 DIELECTRIC FITTING INSTALLATION

- A. See section 220500 "Basic Plumbing Material and Methods".

3.5 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 - 1. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.

2. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.6 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

3.7 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:

1. Piping Inspections:

- a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
- b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
 - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
- c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
- d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

- a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
- b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
- c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
- d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
- e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
- f. Prepare reports for tests and for corrective action required.

- B. Domestic water piping will be considered defective if it does not pass tests and inspections.

- C. Prepare test and inspection reports.

3.8 ADJUSTING

- A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Adjust calibrated balancing valves to flows indicated.
4. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
5. Remove and clean strainer screens. Close drain valves and replace drain plugs.
6. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
7. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.9 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.

2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Repeat procedures if biological examination shows contamination.
 - e. Submit water samples in sterile bottles to authorities having jurisdiction.
- B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.10 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Aboveground domestic water piping, NPS 3 and smaller, shall be the following:
 1. Hard copper tube, ASTM B 88, Type L; wrought-copper, solder-joint fittings; and soldered joints.

3.11 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 1. Shutoff Duty: Use ball valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
 2. Hot-Water Circulation Piping, Balancing Duty: Calibrated balancing valves.
 3. Drain Duty: Hose-end drain valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 221116

SECTION 22 1119 - DOMESTIC WATER PIPING SPECIALTIES

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.
- B. Section 20 0800 "Seismic Protection," Section 22 0100 "Basic Plumbing Requirements," and Section 22 0500 "Basic Plumbing Materials and Methods" all apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

- A. Section Includes:
 - 1. Vacuum breakers.
 - 2. Backflow preventers.
 - 3. Balancing valves.
 - 4. Temperature-actuated, water mixing valves.
 - 5. Strainers.
 - 6. Outlet boxes.
 - 7. Hose bibbs.
 - 8. Wall hydrants.
 - 9. Drain valves.
 - 10. Water-hammer arresters.
 - 11. Specialty valves.
 - 12. Flexible connectors.
 - 13. Water meters.
- B. Related Requirements:
 - 1. Section 220519 "Meters and Gages" for thermometers, pressure gages, and flow meters in domestic water piping.
 - 2. Section 221116 "Domestic Water Piping" for water meters.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For domestic water piping specialties.
 - 1. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. Potable-water piping and components shall comply with NSF 61 Annex G.

2.2 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 VACUUM BREAKERS

- A. Hose-Connection Vacuum Breakers:
 - 1. Standard: ASSE 1011.
 - 2. Body: Bronze, nonremovable, with manual drain.
 - 3. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
 - 4. Finish: For finished areas provide Chrome or nickel plated, and for unfished areas provide Rough bronze.

2.4 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:

1. Acceptable manufacturers: Bell & Gossett, WATTS and Nibco.
2. Type: Ball or Y-pattern globe valve with two readout ports and memory-setting indicator.
3. Body: bronze.
4. Size: Same as connected piping, but not larger than NPS 2.
5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

2.5 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Manifold, Thermostatic, Water Mixing-Valve Assemblies <TMV-1>:

1. Acceptable manufacturers: Acorn, Leonard, Lawler, and Armstrong.
2. Description: Factory-fabricated, exposed-mounted, thermostatically controlled, water mixing-valve assembly.
3. Thermostatic Mixing Valves: Comply with ASSE 1017. Include check stops on hot- and cold-water inlets and shutoff valve on outlet.
4. Pressure Rating: 125 psig minimum unless otherwise indicated.

B. Individual-Fixture, Water Tempering Valves:

1. Acceptable manufacturers: Leonard, Bradley, Zurn and Wilkins.
2. Standard: ASSE 1070, thermostatically controlled, water tempering valve.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.
4. Body: Bronze body with corrosion-resistant interior components.
5. Temperature Control: Adjustable.
6. Inlets and Outlet: Threaded.
7. Finish: Rough or chrome-plated bronze.
8. Tempered-Water Setting: 105 °F
9. Tempered-Water Design Flow Rate: 0.5 gpm.

2.6 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:
 - a. Strainers NPS 2 (DN 50) and Smaller: 0.020 inch.
 - b. Strainers NPS 2-1/2 to NPS 4 (DN 65 to DN 100): 0.045 inch.
6. Drain: Factory-installed, hose-end drain valve.

2.7 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.8 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

1. Acceptable manufacturers: PPP Inc., WATTS, Sioux Chief.
2. Standard: ASSE 1010 or PDI-WH 201.

3. Type: Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.9 FLEXIBLE CONNECTORS

- A. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
 1. Working-Pressure Rating: Minimum 200 psig.
 2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
 3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install balancing valves in locations where they can easily be adjusted.
- B. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
 1. Install cabinet-type units recessed in or surface mounted on wall as specified.
- C. Install Y-pattern strainers for water on supply side of each pump.
- D. Install water-hammer arresters in water piping according to PDI-WH 201.

3.2 CONNECTIONS

- A. Comply with requirements for ground equipment in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Fire-retardant-treated-wood blocking is specified in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical connections.

3.3 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 1. Coordinate list below with products retained in Part 2.
 2. Manifold, thermostatic, water mixing-valve assemblies.
 3. Primary water tempering valves.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 1. Test each reduced-pressure-principle backflow preventer and double-check, backflow-prevention assembly according to authorities having jurisdiction and the device's reference standard.
- B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Set field-adjustable flow set points of balancing valves.
- B. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION 221119

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SECTION 22 1316 - SANITARY WASTE AND VENT PIPING

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.
- B. Section 220100 "Basic Plumbing Requirements," and Section 220500 "Basic Plumbing Materials and Methods" all apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipe, tube, and fittings.
 - 2. Specialty pipe fittings.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For waste and vent piping, 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. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.
- B. Field quality-control reports.

1.5 FIELD CONDITIONS

- A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Construction Manager and Owner no fewer than two weeks in advance of proposed interruption of sanitary waste service.
 - 2. Do not proceed with interruption of sanitary waste service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.
- B. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.2 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
- B. Pipe and Fittings shall be "Made In The U.S.A".

2.3 PVC PIPE AND FITTINGS

- A. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-DWV" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.
- B. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
- C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- D. Adhesive Primer: ASTM F 656.

1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Adhesive primer shall comply with the testing and product requirements of the California Department of Health Services, "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- E. Solvent Cement: ASTM D 2564.
1. Adhesive primer shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Adhesive primer shall comply with the testing and product requirements of the California Department of Health Services, "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
 2. Unshielded, Non-pressure Transition Couplings:
 - a. Acceptable manufacturers; Fernco, Anaco-Huskey, and Joints Coupling.
 - b. Standard: ASTM C 1173.
 - c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - d. End Connections: Same size as and compatible with pipes to be joined.
 - e. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
 3. Shielded, Non-pressure Transition Couplings:
 - a. Acceptable manufacturers; Mission, MIFAB, or CREMCO.
 - b. Standard: ASTM C 1460.
 - c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - d. End Connections: Same size as and compatible with pipes to be joined.

PART 3 - EXECUTION

3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
 2. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 200800 "Seismic Protection". Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.

1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
 2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.
 - a. Straight tees, elbows, and crosses may be used on vent lines.
 3. Do not change direction of flow more than 90 degrees.
 4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
 - a. Reducing size of waste piping in direction of flow is prohibited.
- K. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:
1. Horizontal Sanitary Waste: 2 percent downward in direction of flow for piping NPS 2 and smaller; 1 percent downward in direction of flow for piping NPS 3 and larger.
 2. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- L. Install aboveground PVC piping according to ASTM D 2665.
- M. Install underground PVC piping according to ASTM D 2321.
- N. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- O. Install sleeves for piping penetrations of walls, ceilings, and floors.
1. Comply with requirements for sleeves specified in Section 220500 "Basic Plumbing Material and Methods."
- P. Install sleeve seals for piping penetrations of concrete walls and slabs.
1. Comply with requirements for sleeve seals specified in Section 220500 "Basic Plumbing Material and Methods."
 2. Install escutcheons for piping penetrations of walls, ceilings, and floors.
 3. Comply with requirements for escutcheons specified in Section 220500 "Basic Plumbing Material and Methods."

3.3 JOINT CONSTRUCTION

- A. Plastic, Non-pressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 appendixes.

3.4 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
1. Install transition couplings at joints of piping with small differences in ODs.
 2. In Waste Drainage Piping: [Unshielded] [Shielded], non-pressure transition couplings.

3.5 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect waste and vent piping to the following:
1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
 4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
 5. Comply with requirements for cleanouts and drains specified in Section 221319 "Sanitary Waste Piping Specialties."
 6. Equipment: Connect waste piping as indicated.
 - a. Provide shutoff valve if indicated and union for each connection.
 - b. Use flanges instead of unions for connections NPS 2-1/2 and larger.

- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- E. Make connections according to the following unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.6 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping.
- B. Comply with requirements for identification specified in Section 220500 "Basic Plumbing Materials and Methods"

3.7 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
 - a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
 - 3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.
 - a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
 - b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
 - c. Inspect joints for leaks.
 - 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.
 - a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg.
 - b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
 - c. Air pressure must remain constant without introducing additional air throughout period of inspection.
 - d. Inspect plumbing fixture connections for gas and water leaks.
 - 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 6. Prepare reports for tests and required corrective action.

3.8 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.
- D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

- E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.9 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil, waste, and vent piping NPS 8 and smaller shall be the following:
 - 1. Solid-wall schedule 40 PVC pipe, PVC socket fittings, and solvent-cemented joints.

END OF SECTION 221316

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SECTION 22 1319 - SANITARY WASTE PIPING SPECIALTIES

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.
- B. Section 200800 "Seismic Protection," Section 220100 "Basic Plumbing Requirements," and Section 220500 "Basic Plumbing Materials and Methods" all apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

- A. Section Includes:
 - 1. Cleanouts.
 - 2. Roof flashing assemblies.
 - 3. Through-penetration firestop assemblies.
 - 4. Miscellaneous sanitary drainage piping specialties.
 - 5. Floor drains.
- B. Related Requirements:
 - 1. Section 221423 "Storm Drainage Piping Specialties" for trench drains for storm water, channel drainage systems for storm water, roof drains, and catch basins.

1.3 DEFINITIONS

- A. PVC: Polyvinyl chloride.
- B. FRP: Fiberglass-reinforced plastic.
- C. HDPE: High-density polyethylene.
- D. PE: Polyethylene.
- E. PP: Polypropylene.

1.4 ACTION SUBMITTALS

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

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For sanitary waste piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTIONS

- A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary waste piping specialty components.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing, and marked for intended location and application.

2.2 CLEANOUTS

- A. Cast-Iron Exposed Cleanouts:
 - 1. Approved manufacturers are J. R. Smith, Josam, and Zurn.
 - 2. Standard: ASME A112.36.2M.
 - 3. Size: Same as connected drainage piping
 - 4. Body Material: As required to match connected piping.
 - 5. Closure: Countersunk or raised-head, brass plug.
 - 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
- B. Cast-Iron Exposed Floor Cleanouts <FCO>:
 - 1. Approved manufacturers are J. R. Smith, Josam, and Zurn.
 - 2. Standard: ASME A112.36.2M for threaded, adjustable housing cleanout.
 - 3. Size: Same as connected branch.
 - 4. Type: Threaded, adjustable housing.
 - 5. Body or Ferrule: Cast iron.
 - 6. Closure: Brass plug with tapered threads.

7. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
8. Frame and Cover Shape: Round.
9. Top Loading Classification: Medium Duty.
10. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:

1. Approved manufacturers are J. R. Smith, Josam, and Zurn.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: As required to match connected piping.
5. Closure Plug:
 - a. Brass.
 - b. Countersunk or raised head.
 - c. Drilled and threaded for cover attachment screw.
 - d. Size: Same as or not more than one size smaller than cleanout size.
6. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
7. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

2.3 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.
 - a. NPS 2: 4-inch-minimum water seal.
 - b. NPS 2-1/2 and Larger: 5-inch-minimum water seal.

B. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

2.4 DRAIN ASSEMBLIES

- A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary piping specialty components.

2.5 FLOOR DRAINS

A. Cast-Iron Floor Drains <FD-1>:

1. Approved manufacturers are MIFAB, J. R. Smith and Zurn.
2. Standard: ASME A112.6.3.
3. See schedule on drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment Mounting:

1. Comply with requirements for vibration-isolation devices specified in Section 220548 "Vibration Controls for Plumbing Piping and Equipment."

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- E. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."
- F. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."
- G. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.
 - 1. Comply with requirements in Section 078413 "Penetration Firestopping."
- H. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- I. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
 - 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 - 2. Size: Same as floor drain inlet.
- J. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- K. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.
- L. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
- M. Install fire-rated wood-blocking reinforcement for wall-mounting-type specialties.
- N. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- O. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 - 1. Position floor drains for easy access and maintenance.
 - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
 - 3. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
 - 4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.
 - a. Maintain integrity of waterproof membranes where penetrated.
 - 5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- P. Comply with ASME A112.3.1 for installation of stainless-steel channel drainage systems.
 - 1. Install on support devices, so that top will be flush with adjacent surface.

3.2 CONNECTIONS

- A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- E. Comply with requirements in Section 221319 "Sanitary Waste Piping Specialties" for backwater valves, air admittance devices and miscellaneous sanitary drainage piping specialties.

3.3 FLASHING INSTALLATION

- A. Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."
- B. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required.
- C. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

- D. Set flashing on floors and roofs in solid coating of bituminous cement.
- E. Secure flashing into sleeve and specialty clamping ring or device.
- F. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Section 076200 "Sheet Metal Flashing and Trim."
- G. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

3.4 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign:
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.
 - 1. Nameplates and signs are specified in Section 220500 Basic Plumbing Materials and Methods."

3.5 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319

SECTION 22 4300 - PLUMBING FIXTURES

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.
- B. Section 220100 "Basic Plumbing Requirements," and Section 220500 "Basic Plumbing Materials and Methods" all apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

- A. Section includes the following fixtures and specialties:
 - 1. Water closets.
 - 2. Flushometer valves.
 - 3. Toilet seats.
 - 4. Sinks.
 - 5. Outlet boxes.
 - 6. Supports.
 - 7. Lavatories.
 - 8. Urinals.
 - 9. Electric water coolers.
 - 10. Emergency plumbing fixture.

1.3 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 fixtures.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For plumbing fixtures and faucets to include in operation and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Servicing and adjustments of flushometer valves.

PART 2 - PRODUCTS

2.1 WATER CLOSETS

- A. Water Closets.
 - 1. Acceptable manufacturers: Kohler, American Standard and Sloan.

2.2 URINALS

- A. Urinals.
 - 1. Acceptable manufacturers: Kohler, American Standard and Sloan.

2.3 FLUSH VALVES

- A. Flush valves.
 - 1. Acceptable manufacturers: Sloan, Zurn and Moen.

2.4 LAVATORIES

- A. Lavatories.
 - 1. Acceptable manufacturers: Kohler, American Standard and Sloan.

2.5 LAVATORY FAUCETS

- A. Lavatory faucets.
 - 1. Acceptable manufacturers: Sloan, T&S, American Standard, Kohler, Delta, Zurn and Chicago Faucet.
 - 2. For public lavatories include ASSE 1070 certified mixing device, see Section 221119 "Domestic Water Piping Specialties".

2.6 TOILET SEATS

- A. Toilet Seats.
 - 1. Acceptable manufacturers: Bemis, Church, and Beneke.

2.7 ELECTRIC WATER COOLERS

- A. Electric water coolers.
 - 1. Acceptable manufacturers: Oasis, Elkay and Haws.

2.8 EMERGENCY PLUMBING FIXTURES

- A. Emergency plumbing fixtures.
 - 1. Acceptable manufacturers: Bradley, Guardian and Speakman.

2.9 SINK FAUCETS

- A. Sink faucets.
 - 1. Acceptable manufacturers: Sloan, T&S, American Standard, Kohler, Delta, Zurn and Chicago Faucet.

2.10 LAMINAR-FLOW, FAUCET-SPOUT OUTLETS

- A. Description: Chrome-plated brass, faucet-spout outlet that produces non-aerating, laminar stream. Include external or internal thread that mates with faucet outlet for attachment to faucets where indicated and flow-rate range that includes faucet flow.
- B. NSF Standard: Comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects," for faucet-spout-outlet materials that will be in contact with potable water.

2.11 OUTLET BOXES

- A. Outlet Boxes.
 - 1. Acceptable manufacturers: Sioux Chief, Acorn and Bradley.

2.12 SUPPORTS (CARRIERS)

- A. Supports (carriers).
 - 1. Acceptable manufacturers: Zurn, Josam and Jay R. Smith.

2.13 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.
- B. Standard: ASME A112.18.1/CSA B125.1.
- C. Supply Piping: Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless-steel wall flange.
- D. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
- E. Operation: Loose key.
- F. Risers: NPS 1/2 chrome-plated, rigid-copper pipe and brass straight or offset tailpieces.

2.14 WASTE FITTINGS

- A. Waste fittings
 - 1. Acceptable manufacturers: Keeney Mfg, Wolverine Brass and Dearborn Brass.

2.15 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.
- B. Examine walls, floors, cabinets, and counters for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install plumbing fixtures level and plumb according to roughing-in drawings & manufacturer's instructions.
- B. Install supports, affixed to building substrate, for wall-mounted fixtures.
 - 1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
 - 2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
 - 3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
- C. Install counter-mounted fixtures in and attached to casework.
- D. Install water-supply piping with stop on each supply to each fixture, including showers, to be connected to water-distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
 - 1. Exception: Use ball or gate valve if supply stops are not specified with fixture. Comply with valve requirements specified in Section 220523 "Ball Valves."
- E. Install flushometer valves on water closets & urinals.
- F. Install flushometer valves for accessible water closets & urinals with lever handle mounted on wide side of compartment.
- G. Install toilet seats on water closets.
- H. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts, if faucets are not available with required rates and patterns. Include adapters if required.
- I. Install laminar-flow, faucet-spout fittings in faucet spouts where laminar-flow fittings are specified.
- J. Install shower flow-control fittings with specified maximum flow rates in shower arms.
- K. Install traps on fixture outlets.
 - 1. Exception: Omit trap on fixtures with integral traps.
- L. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."
- M. Seal joints between plumbing fixtures, counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
- N. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220500 "Valves.."
- O. Install accessible plumbing fixtures at handicapped/elderly mounting heights according to ICC/ANSI A117.1.
- P. Install an ASSE 1070 mixing device at each point of use location for every public lavatory.

3.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with requirements for water piping specified in Section 221116 "Domestic Water Piping."
- C. Comply with requirements for soil and waste drainage piping and vent piping specified in Section 221316 "Sanitary Waste and Vent Piping."
- D. Comply with requirements for atmospheric vent piping specified in Section 221316 "Sanitary Waste and Vent Piping."

- E. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.4 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning plumbing fixtures, fittings, and controls.
- B. Adjust water pressure at faucets and flushometer valves to produce proper flow.
- C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

- A. After installing plumbing fixtures, inspect and repair damaged finishes.
- B. Clean plumbing fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed fixtures and fittings.
- D. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224300

SECTION 22 6113 - COMPRESSED-AIR PIPING FOR LABORATORY FACILITIES

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.
- B. Section 200800 "Seismic Protection," Section 220100 "Basic Plumbing Requirements," and Section 220500 "Basic Plumbing Materials and Methods" all apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

- A. Section Includes:
 - 1. Medical compressed-air piping, designated "medical air."
 - 2. Dental compressed-air piping, designated "dental air."
 - 3. Gas-powered-tool compressed-air piping, designated "instrument air."
 - 4. Healthcare laboratory compressed-air piping, designated "medical laboratory air."
 - 5. Compressed-air piping and specialties for nonmedical laboratory facilities, designated "laboratory air."
- B. Related Requirements:
 - 1. Section 115313 "Laboratory Fume Hoods" for compressed-air outlets in laboratory fume hoods.
 - 2. Section 123553 "Laboratory Casework" for compressed-air outlets in laboratory casework.

1.3 DEFINITIONS

- A. Medical compressed-air piping systems include medical air, dental air, instrument air, and medical laboratory air.
- B. Nonmedical compressed-air piping systems include laboratory air piping systems.

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and testing agency.
- B. Material Certificates: Signed by Installer certifying that medical compressed-air piping materials comply with requirements in NFPA 99 for positive-pressure medical gas systems.
- C. Brazing certificates.
- D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For compressed-air piping specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Medical Air Piping Systems for Healthcare Facilities: According to ASSE Standard #6010 for medical-gas-system installers.
 - 2. Shape-Memory-Metal Coupling Joints: An authorized representative who is trained and approved by manufacturer.
- B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL, and that is acceptable to authorities having jurisdiction.
 - 1. Qualify testing personnel according to ASSE Standard #6020 for medical-gas-system inspectors and ASSE Standard #6030 for medical-gas-system verifiers.
- C. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications"; or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Laboratory air operating at 50 psig.

2.2 PIPES, TUBES, AND FITTINGS

- A. Comply with NFPA 99 for medical air piping materials.
- B. Comply with ASME B31.9, "Building Services Piping," for laboratory air piping operating at 150 psig (1035 kPa) or less.
- C. Copper Medical Gas Tube: ASTM B 819, Type L, seamless, drawn temper, that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and in blue for Type L tube.
- D. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type that has been manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
- E. Copper Unions: ASME B16.22 or MSS SP-123, wrought-copper or cast-copper alloy.
- F. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150.
 - 1. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch (3.2-mm) maximum thickness, full-face type.
 - 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.

2.3 JOINING MATERIALS

- A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.
- B. Threaded-Joint Tape: PTFE.

2.4 VALVES

- A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
- B. Ball Valves:
 - 1. Acceptable manufacturers: Beacon Medaes, Amico and Chemetron.
 - 2. Standard: MSS SP-110.
 - 3. Description: Three-piece body, brass or bronze.
 - 4. Pressure Rating: 300 psig (2070 kPa) minimum.
 - 5. Ball: Full-port, chrome-plated brass.
 - 6. Seats: PTFE or TFE.
 - 7. Handle: Lever.
 - 8. Stem: Blowout proof with PTFE or TFE seal.
 - 9. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- C. Pressure Regulators:
 - 1. Bronze body and trim.
 - 2. Spring-loaded, diaphragm-operated, relieving type.
 - 3. Manual pressure-setting adjustment.
 - 4. Rated for 250-psig (1725-kPa) minimum inlet pressure.
 - 5. Capable of controlling delivered air pressure within 0.5 psig for each 10-psig (5.0 kPa for each 100-kPa) inlet pressure.

2.5 NITROGEN

- A. Comply with USP 32 - NF 27 for oil-free dry nitrogen.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing is not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:
 - 1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1.

2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb (0.453 kg) of chemical to 3 gal. (11.3 L) of water.
 - a. Scrub to ensure complete cleaning.
 - b. Rinse with clean, hot water to remove cleaning solution.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of compressed-air piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Comply with NFPA 99 for installation of compressed-air piping.
- C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
- F. Install piping adjacent to equipment and specialties to allow service and maintenance.
- G. Install compressed-air piping with 1 percent slope downward in direction of flow.
- H. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications specified in "Piping Schedule" Article unless otherwise indicated.
- I. Install eccentric reducers, if available, where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
- J. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.
- K. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver. Comply with requirements in Section 220519 "Meters and Gages for Plumbing Piping."
- L. Install piping to permit valve servicing.
- M. Install piping free of sags and bends.
- N. Install fittings for changes in direction and for branch connections.
- O. Install medical air piping to medical air service connections specified in this Section, to medical air service connections in equipment specified in Section 226313 "Gas Piping for Laboratory and Healthcare Facilities," and to equipment specified in other Sections requiring medical air service.
- P. Install compressed-air service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
- Q. Connect compressed-air piping to air compressors and to compressed-air outlets and equipment requiring compressed-air service.
- R. Install unions in copper compressed-air tubing adjacent to each valve and at final connection to each machine, specialty, and piece of equipment.
- S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220500 "Basic Plumbing Materials and Methods."
- T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220500 "Basic Plumbing Materials and Methods."

3.3 VALVE INSTALLATION

- A. Install shutoff valve at each connection to and from compressed-air equipment and specialties.
- B. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
- C. Install pressure regulators on compressed-air piping where reduced pressure is required.

3.4 JOINT CONSTRUCTION

- A. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
- B. Threaded Joints: Apply appropriate tape to external pipe threads.
- C. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" chapter. Continuously purge joint with oil-free dry nitrogen during brazing.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.

3.6 IDENTIFICATION

- A. Install identifying labels and devices for nonmedical laboratory compressed-air piping, valves, and specialties. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment."
- B. Install identifying labels and devices for medical compressed-air piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
 - 1. Laboratory Air: White letters on blue background.

3.7 FIELD QUALITY CONTROL FOR COMPRESSED-AIR PIPING IN NONMEDICAL LABORATORY FACILITIES

- A. Testing Agency: Engage qualified testing agency to perform tests and inspections of compressed-air piping in nonmedical laboratory facilities and to prepare test and inspection reports.
- B. Tests and Inspections:
 - 1. Piping Leak Tests for Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill compressed-air piping with oil-free dry nitrogen to pressure of 50 psig (345 kPa) above system operating pressure, but not less than 150 psig (1035 kPa). Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
 - 2. Repair leaks and retest until no leaks exist.
 - 3. Inspect filters and pressure regulators for proper operation.
- C. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.8 PROTECTION

- A. Protect tubing from damage.
- B. Retain sealing plugs in tubing, fittings, and specialties until installation.
- C. Clean tubing not properly sealed, and where sealing is damaged, according to "Preparation" Article.

3.9 PIPING SCHEDULE

- A. Connect new tubing to existing tubing with memory-metal couplings.
- B. Laboratory Air Piping NPS 3 (DN 80) and smaller Operating at Less Than 185 psig (1275 kPa): Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

3.10 VALVE SCHEDULE

- A. Shutoff Valves: Ball valve with manufacturer-installed ASTM B 819, copper-tube extensions.

END OF SECTION 226113

SECTION 22 6213 - VACUUM PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

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.
- B. Section 220100 "Basic Plumbing Requirements," and Section 220500 "Basic Plumbing Materials and Methods" all apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

- A. Section Includes:
 - 1. Laboratory vacuum piping, designated "laboratory vacuum."
- B. Related Requirements:
 - 1. Section 115313 "Laboratory Fume Hoods" for vacuum inlets in laboratory fume hoods.
 - 2. Section 123553 "Laboratory Casework" for vacuum inlets in laboratory casework.
 - 3. Section 123570 "Healthcare Casework" for vacuum inlets in healthcare casework.
 - 4. Section 226219 "Vacuum Equipment for Laboratory and Healthcare Facilities" for vacuum producers and accessories.
 - 5. Section 226400 "Medical Gas Alarms" for vacuum piping alarms.

1.3 DEFINITIONS

- A. Nonmedical laboratory vacuum piping systems include laboratory vacuum.

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and testing agency.
- B. Material Certificates: Signed by Installer certifying that medical vacuum piping materials comply with requirements in NFPA 99.
- C. Brazing certificates.
- D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For vacuum piping specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Medical Vacuum Piping Systems for Healthcare Facilities: According to ASSE Standard #6010 for medical-gas-system installers.
- B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL, and that is acceptable to authorities having jurisdiction.
 - 1. Qualify testing personnel according to ASSE Standard #6020 for medical-gas-system inspectors and ASSE Standard #6030 for medical-gas-system verifiers.
- C. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications"; or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Laboratory vacuum operating at 15 in. Hg.

2.2 PIPES, TUBES, AND FITTINGS

- A. Copper Medical Gas Tube: ASTM B 819, Type L, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in blue.
- B. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service.
- C. Copper Unions: ASME B16.22 or MSS SP-123, wrought-copper or cast-copper alloy.

2.3 JOINING MATERIALS

- A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.
- B. Threaded-Joint Tape: PTFE.

2.4 VALVES

- A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
- B. Copper-Alloy Ball Valves:
 - 1. Acceptable manufacturers: Beacon Medeas, Amico, and Chemetron.
 - 2. Standard: MSS SP-110.
 - 3. Description: Three-piece body, brass or bronze.
 - 4. Pressure Rating: 300 psig (2070 kPa) minimum.
 - 5. Ball: Full-port, chrome-plated brass.
 - 6. Seats: PTFE or TFE.
 - 7. Handle: Lever type with locking device.
 - 8. Stem: Blowout proof with PTFE or TFE seal.
 - 9. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions with vacuum gage on one copper-tube extension.

2.5 NITROGEN

- A. Comply with USP 32 - NF 27 for oil-free dry nitrogen.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing is not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:
 - 1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1.
 - 2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb (0.453 kg) of chemical to 3 gal. (11.3 L) of water.
 - a. Scrub to ensure complete cleaning.
 - b. Rinse with clean, hot water to remove cleaning solution.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of vacuum piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, vacuum producer sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Comply with NFPA 99 for installation of vacuum piping.
- C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
- F. Install piping adjacent to equipment and specialties to allow service and maintenance.
- G. Install vacuum piping with 1 percent slope downward in direction of flow.

- H. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than piping pressure rating used in applications specified in "Piping Schedule" Article unless otherwise indicated.
- I. Install eccentric reducers, if available, where vacuum piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
- J. Provide drain leg and drain trap at end of each main and branch and at low points.
- K. Install thermometer and vacuum gage on inlet piping to each vacuum producer and on each receiver and separator. Comply with requirements in Section 220519 "Meters and Gages for Plumbing Piping."
- L. Install piping to permit valve servicing.
- M. Install piping free of sags and bends.
- N. Install fittings for changes in direction and for branch connections. Extruded-tee branch outlets in copper tubing may be made where specified.
- O. Install medical vacuum piping from medical vacuum service connections specified in this Section, to equipment specified in Section 226219 "Vacuum Equipment for Laboratory and Healthcare Facilities," and to equipment specified in other Sections requiring medical vacuum service.
- P. Piping Restraint Installation: Install seismic restraints on vacuum piping. Seismic-restraint devices are specified in Section 200800 "Seismic Protection."
- Q. Install medical vacuum service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
- R. Install medical vacuum bottle bracket adjacent to each wall-mounted medical vacuum service connection suction inlet.
- S. Connect vacuum piping to vacuum producers and to equipment requiring vacuum service.
- T. Install unions in copper vacuum tubing adjacent to each valve and at final connection to each machine, specialty, and piece of equipment.
- U. Install unions in PVC vacuum piping NPS 2 (DN 50) and smaller adjacent to each valve and at final connection to each machine, specialty, and piece of equipment.
- V. Install flanges in PVC vacuum piping NPS 2-1/2 (DN 65) and larger adjacent to flanged valves and at final connection to each machine, specialty, and piece of equipment.
- W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220500 Basic Plumbing Materials and Methods."
- X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220500 Basic Plumbing Materials and Methods."

3.3 VALVE INSTALLATION

- A. Install shutoff valve at each connection to and from vacuum equipment and specialties.

3.4 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Threaded Joints: Apply appropriate tape to external pipe threads.
- E. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" chapter. Do not use flux. Continuously purge joint with oil-free dry nitrogen during brazing.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.

3.6 IDENTIFICATION

- A. Install identifying labels and devices for laboratory vacuum piping, valves, and specialties. Comply with requirements in Section 220500 Basic Plumbing Material and Methods."
- B. Install identifying labels and devices for medical vacuum piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
 - 1. Laboratory Vacuum: Black boxed letters on white-and-black checkerboard background.

3.7 FIELD QUALITY CONTROL FOR LABORATORY FACILITY NONMEDICAL VACUUM PIPING

- A. Testing Agency: Engage qualified testing agency to perform field tests and inspections of vacuum piping in nonmedical laboratory facilities and to prepare test and inspection reports.
- B. Tests and Inspections:

1. Piping Leak Tests for Vacuum Piping: Test new and modified parts of existing piping. Cap and fill vacuum piping with oil-free, dry nitrogen. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
 - a. Test Pressure for Copper Tubing: 100 psig.
 2. Repair leaks and retest until no leaks exist.
 3. Inspect filters for proper operation.
- C. Remove and replace components that do not pass tests and inspections and retest as specified above.
- 3.8 PROTECTION**
- A. Protect tubing from damage.
 - B. Retain sealing plugs in tubing, fittings, and specialties until installation.
 - C. Clean tubing not properly sealed, and where sealing is damaged, according to "Preparation" Article.
- 3.9 PIPING SCHEDULE**
- A. Connect new copper tubing to existing copper tubing with memory-metal couplings.
 - B. Laboratory Vacuum Piping: Use the following piping materials for each size range:
 1. Copper medical gas tube NPS 4 and Smaller: wrought-copper fittings, and brazed joints.
- 3.10 VALVE SCHEDULE**
- A. Shutoff Valves:
 1. Copper Tubing: Oxygen cleaned and bagged copper-alloy ball valve with manufacturer-installed ASTM B 819, copper-tube extensions.

END OF SECTION 226213

**SECTION 22 6700 - PROCESSED WATER PIPING FOR LABORATORY AND HEALTHCARE FACILITIES
(REAGENT, REVERSE OSMOSIS AND DE-IONIZED)**

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.
- B. Section 220100 "Basic Plumbing Requirements," and Section 220500 "Basic Plumbing Materials and Methods" all apply to the work of this Section as if fully repeated herein.

1.2 SUMMARY

- A. Section includes deionized-water piping.

1.3 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure Ratings:
 - 1. Deionized-Water Piping: 50 psig unless otherwise indicated.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For water piping, 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. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.
- B. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. ASME Compliance: Comply with ASME B31.3, "Process Piping," for piping conveying fluid at a pressure of 15 psig (105 kPa) or greater.

PART 2 - PRODUCTS

2.1 PLASTIC PIPE AND FITTINGS

- A. Acceptable manufacturers: Spears.
 - 1. Schedule 80, Low Extractable PVC Pipe and Fittings: ASTM D1784, ASTM D1785, and ASTM D2467; with plain ends for solvent-cemented joints and ASTM F 439, socket-type fittings.
 - a. Pipe and fittings shall be bagged and sealed immediately after manufacture to maintain cleanliness.
 - 2. Solvent Cements for Joining Low Extractable PVC Piping and Tubing:
 - 3. ASTM D2564. The standard practice for safe handling of solvent cements shall be in accordance with ASTM F402.
 - a. Solvent cement shall be NSF certified for potable water.

2.2 TRANSITION FITTINGS

- A. Transition Fittings: Couplings, flanges, or other manufactured fittings; same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.3 LOW EXTRACTABLE PVC VALVES

- A. Low Extractable PVC Ball Valves:
 - 1. Acceptable manufacturers: Spears.
 - 2. Description:

- a. True Union style quarter turn ball valves produced from the same material as the piping and fittings.
- b. All valve diaphragms and seats shall be PTFE; O-rings shall be EPDM or KFM as applicable.
- c. Union nuts shall have buttress style threads.
- d. Valve shall be bagged and sealed immediately after manufacture to maintain cleanliness.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of water piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for removal of ceiling panel, and coordinate with other services occupying that space.
- E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- F. Install piping to permit valve servicing.
- G. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure ratings unless otherwise indicated.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220500 Basic Plumbing Material and Methods."
- K. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220500 Basic Plumbing Material and Methods."
- L. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220500 Basic Plumbing Material and Methods."

3.2 JOINT CONSTRUCTION

- A. Where specific joint construction is not indicated, follow piping manufacturer's written instructions.
- B. PVC Piping Solvent-Cemented Joints: Comply with ASTM F 402 for handling solvent cements, primers, and cleaners; make joints according to ASTM D 2846/D 2846M Appendix.
- C. Join dissimilar pipe materials with transition fittings compatible with pipe materials being joined.

3.3 VALVE INSTALLATION

- A. Install sectional valves close to mains on each branch and riser serving equipment.
- B. Install shutoff valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- C. Locate valves for easy access and provide separate support where necessary.
- D. Install valves of same size as the pipe or tube in which they are installed unless otherwise indicated.
- E. Install plastic valves of the same material as the plastic pipe in which they are installed.
- F. Install valves in horizontal piping with stem at or above center of pipe.
- G. Install valves in position to allow full movement of stem and lever handle.
- H. Install ball-check valves in horizontal or vertical position so ball will unseat during normal flow.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

3.5 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- C. Connect deionized-water piping to equipment and service outlets with unions or flanges.

3.6 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.7 FIELD QUALITY CONTROL

- A. Test new piping, and parts of existing piping that have been altered, extended, or repaired, for leaks and defects.
 - 1. Schedule tests and their inspections by authorities having jurisdiction, with at least 24 hours' advance notice.
 - 2. Do not cover piping or put into service before inspection and approval.
 - 3. Test completed piping according to authorities having jurisdiction. If authorities having jurisdiction do not have published procedures, perform tests as follows:
 - a. Hydrostatic Tests: Test piping at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than 50 psig (345 kPa).
 - 1) Exception: Do not subject glass piping to pressure above manufacturer's pressure rating for size.
 - 4. Replace leaking joints with new materials and retest until no leaks exist.
 - 5. Submit separate reports for each test.

3.8 CLEANING

- A. Use procedures prescribed by authorities having jurisdiction or, if not prescribed, use procedures described below:
 - 1. Before using, purge new piping and parts of existing piping that have been altered, extended, or repaired.
 - 2. Clean piping by flushing with deionized water.

3.9 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping, and of same or compatible material, may be used in applications below.
- B. Deionized-Water Piping: Use the following piping materials for each pipe size range:
 - 1. NPS 3 and Smaller: Low Extractable PVC pipe and fittings and solvent-cement joints.

3.10 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Install ball valves in piping NPS 2 (DN 50) and smaller.

END OF SECTION 226700

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SECTION 22 6800 - FACILITY NATURAL-GAS PIPING

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. Pipes, tubes, and fittings.
 - 2. Piping specialties.
 - 3. Piping and tubing joining materials.
 - 4. Manual gas shutoff valves.
 - 5. Dielectric fittings.

1.3 DEFINITIONS

- A. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Piping specialties.
 - 2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
 - 3. Pressure regulators. Indicate pressure ratings and capacities.
 - 4. Service meters. Indicate pressure ratings and capacities.
 - 5. Dielectric fittings.
- B. Delegated-Design Submittal: For natural-gas piping and equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Detail fabrication and assembly of seismic restraints.
 - 2. Design Calculations: Calculate requirements for selecting seismic restraints.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.
- B. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.
- C. Qualification Data: For qualified professional engineer.
- D. Welding certificates.
- E. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pressure regulators and service meters to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- 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.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.
- B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

1.9 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.
- B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
 - 1. Notify Owner no fewer than 7 days in advance of proposed interruption of natural-gas service.
 - 2. Do not proceed with interruption of natural-gas service without Owner's written permission.

1.10 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Section 083113 "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
 - 1. Piping and Valves: 100 psig minimum unless otherwise indicated.
 - 2. Service Regulators: 65 psig minimum unless otherwise indicated.
 - 3. Minimum Operating Pressure of Service Meter: 5 psig.
- B. Natural-Gas System Pressure within Buildings: More than 0.5 psig but not more than 2 psig.
- C. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

2.2 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 - 2. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.

2.3 PIPING SPECIALTIES

- A. Y-Pattern Strainers:
 - 1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
 - 2. End Connections: Threaded ends for NPS 2 and smaller.
 - 3. Strainer Screen: 40-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
 - 4. CWP Rating: 125 psig.
- B. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.4 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.

2.5 MANUAL GAS SHUTOFF VALVES

- A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
- B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.

1. CWP Rating: 125 psig.
 2. Threaded Ends: Comply with ASME B1.20.1.
 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
- C. Cast-Iron, Lubricated Plug Valves: MSS SP-78.
1. Body: Cast iron, complying with ASTM A126, Class B.
 2. Plug: Bronze or nickel-plated cast iron.
 3. Seat: Coated with thermoplastic.
 4. Stem Seal: Compatible with natural gas.
 5. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 6. Operator: Square head or lug type with tamperproof feature where indicated.
 7. Pressure Class: 125 psig.
 8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.6 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
1. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 125 psig minimum at 180 deg F.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping according to the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 INDOOR PIPING INSTALLATION

- A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Verify final equipment locations for roughing-in.

- L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- O. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- P. Connect branch piping from top or side of horizontal piping.
- Q. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- R. Do not use natural-gas piping as grounding electrode.
- S. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- T. Install pressure gage downstream from each line regulator. Pressure gages are specified in Section 220519 "Meters and Gages."
- U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230500 "Basic Plumbing Materials and Methods."
- V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230500 "Basic Plumbing Materials and Methods."
- W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230500 "Basic Plumbing Materials and Methods."

3.4 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
- B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- C. Install earthquake valves aboveground outside buildings according to listing.

3.5 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 - 2. Cut threads full and clean using sharp dies.
 - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 - 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
 - 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

3.6 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hangers and supports specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

3.7 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.8 LABELING AND IDENTIFYING

- A. Comply with requirements in Section 220500 "Basic Plumbing Materials and Methods".

3.9 PAINTING

- A. Comply with requirements in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" for painting interior and exterior natural-gas piping.
- B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
 - 1. Alkyd System: MPI EXT 5.1D.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - c. Topcoat: Exterior alkyd enamel semigloss.
 - d. Color: Yellow.

3.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.
- C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.11 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain earthquake valves.

3.12 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG AND LESS THAN 5 PSIG

- A. Aboveground piping NPS 3 and smaller shall be the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.

3.13 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Distribution piping valves for pipe sizes NPS 2 (DN 50) and smaller shall be one of the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.
- B. Distribution piping valves for pipe sizes NPS 2-1/2 (DN 65) and larger shall be **one of** the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.
 - 3. Cast-iron, nonlubricated plug valve.

END OF SECTION 226800

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SECTION 23 0100 – BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes general administrative and procedural requirements for mechanical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 01:
 - 1. Submittals.
 - 2. Material and Equipment Selection.
 - 3. Coordination drawings.
 - 4. Record documents.
 - 5. Maintenance manuals.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this and the other sections of Division 23.

1.3 CONTRACTOR'S SUBMITTAL RESPONSIBILITIES

- A. General: Follow the procedures specified in Division 01. In addition to the requirements specified in Division 01, comply with the following:
 - 1. Increase by two (2) the quantity of print copies required by Division 01 for submittals, if paper submittals are used. (Paperless electronic submittals are preferred.)
 - 2. Electronic Submittals: Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number. Transmit via email. Include PDF transmittal form. Include information in email subject line as to project name, project number, submittal number, and applicable specification section number.
 - 3. Submit line-by-line specification verification for equipment other than the "basis of design" as further described in the following article "Material and Equipment Selection".
- B. General: Submittals are not requested for all products covered in the specifications. Submit only the data requested under the submittals portion of each specification section or where indicated in a Submittal Log, if included within Division 01. Un-requested submittals will not be processed, reviewed or returned and the contractor will be notified that the submittal will not be reviewed by the engineer of record.
 - 1. Non-requirement of submittals, when so noted, is not to be construed as an allowance for substitutions and does not relieve the contractor from full compliance with the plans and specifications.
 - 2. Any deviation from specified items is considered a substitution. If the contractor desires to use other than specified items, then a formal request for substitution must be submitted prior to bid date (no exceptions), in accordance with the procedures and time limitations set forth in Division 01. Where not defined in Division 01, requests for substitutions shall be submitted no less than ten (10) working days prior to bid date. Review of substitution requests by the Engineer shall be done at the expense of the contractor. Charges for this substitution review shall be calculated based on the Engineer's standard hourly rates, as defined in their contract with the Owner.
- C. It is the responsibility of the Contractor to ensure that all submittals have been reviewed for total completeness and accuracy as to the requirements of the specifications and drawings before being submitted to the Engineer for review.
 - 1. One comprehensive submittal shall be provided for each individual specification section. All required submittal information called for in each individual specification section shall be included in the submittal.
 - 2. The Engineer of Record shall not be responsible for informing the contractor on items that have not been included and are necessary for a complete review of the required submittal information for a specification section.
 - 3. The Engineer of Record shall have the option of returning any submittal, unmarked, if all required documentation called for in the specifications has not been provided in the submittal.
 - 4. The Engineer of Record shall review each submittal no more than two (2) times and return to the contractor with the appropriate disposition.
 - 5. If the Engineer of Record is required to review a submittal a second time, it shall be limited to review of the changed information, clearly highlighted by the submitter, and/or confirmation of documentation only and it shall be returned to the contractor with the appropriate disposition.

6. If the submittal is required to be reviewed a third time, it shall be done at the expense of the contractor. Charges for this additional submittal review shall be calculated based on the Engineer's standard hourly rates, as defined in their contract with the Owner.
- D. Operation and Maintenance Manuals: All items required for insertion into each Operation and Maintenance (O&M) Manual are called out in the submittals portion of each specification section or in a Submittal Log, if included within Division 01. It is the responsibility of the Contractor to ensure that the O&M submittal has been reviewed and includes all the requirements of the specifications. The Engineer of Record shall review the submittal for the Operation and Maintenance Manual one (1) time and return to the contractor with the appropriate disposition.
 1. If the submittal is required to be reviewed a second time, it shall be done at the expense of the contractor. Charges for this additional submittal review shall be calculated based on the Engineer's standard hourly rates, as defined in their contract with the Owner.
 2. Submittals for the Operation and Maintenance Manual must be original documentation.
 3. Photo copies of marked up Operations and Maintenance submittals are not acceptable.
- E. Coordination Drawings: Prepare and submit Coordination Drawings as further described herein and as indicated in the Special Conditions. The Engineer shall receive one copy of all coordination drawings supplied to the Owner as required in this specification. It is the responsibility of the Contractor to coordinate the work as outlined herein. Receipt by the Engineer of a copy of the coordination drawings is to verify conformance to the submittal requirements set forth in this specification section. It is not an admission by the Engineer as to the accuracy or completeness of the coordination proposed.
- F. Refer to Division 01 and each individual Division 23 Section for additional submittal requirements.

1.4 REFERENCED STANDARDS

- A. American Society of Heating, Refrigerating and Air-Conditioning Engineers. Guideline 4-2008 (RA 2013) *Preparation of Operating and Maintenance Documentation for Building Systems*. Atlanta, GA: ASHRAE, 1993.

1.5 MATERIAL AND EQUIPMENT SELECTION

- A. Product Options: The specification of each item of major mechanical equipment required for the project may include a list of manufacturers, with one "basis of design" manufacturer, type, and model identified by virtue of their listing in the equipment schedule on the Drawings. Where several manufacturers in addition to the "basis of design" manufacturer are listed in the specifications, it shall be understood that the words "or approved equal by" are implied to precede each of the other manufacturer's names.
 1. The manufacturers other than the "basis of design" may be furnished at the contractor's option in lieu of the "basis of design" product, provided that the selected manufacturer's product is equal in all material and functional respects. In addition to submittal requirements that may be specified in this section, submit a line-by-line written verification of the applicable specification section(s) identifying compliance with or variations from the specified features, materials, performance, capacities, weight, size, durability, energy consumption and efficiency, warranty, and visual impact (if exposed to view by other than maintenance persons). The burden of proof of manufacturer/product equality is on the contractor.
 2. Where a product is not scheduled on the drawings and, therefore, where no "basis of design" is indicated, selection among all of the listed manufacturers and products is at the contractor's option, subject to the requirements of the Contract Documents.
 3. Products of manufacturers not listed in the Contract Documents are considered Substitutions and are not permitted, except as provided under the General and Supplementary Conditions and Division 01 Specifications. Full compliance with Division 01 section "Product Substitutions" is mandatory for acceptance of products or manufacturers not listed.
- B. Listing of a manufacturer does not imply approval of that manufacturer's standard product or products. Rather, listing of a manufacturer indicates only a general acceptance of that manufacturer's name and reputation. Final approval is subject to full compliance with these Contract Documents.
- C. Model numbers identified on the Drawings notwithstanding, all equipment must comply with the requirements of these Contract Documents. Do not assume that a manufacturer's standard product is acceptable as is. For example, one or more custom modifications, custom colors or finishes, manufacturer's options, and/or accessories may be required to meet the specified requirements.
- D. Where drawings indicate sizes, profiles, connections, and dimensional requirements of material and equipment, these are based on the "basis of design" manufacturer, type and model indicated. In the event that equipment of power, dimensions, capacities, layout, connections, and/or ratings differing from the "basis of design" are selected by the contractor and approved by the Owner's representative, any necessary

adjustments are the contractor's responsibility. All connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, pipe and duct sizes, pipe and duct layout, and the like shall be adjusted by the contractor to suit the equipment provided. No additional costs will be approved for these changes. Should revisions to the design because of contractor's selection of manufacturer, type, or model other than the "basis of design" require additional review and/or redesign by an Architect or Engineer, the contractor shall reimburse the Owner for Owner's added professional fee expenses.

- E. Where two or more materials are listed in the "Part 2 – Products" subsection of any Division 23 section, do not assume that the selection of materials is the contractor's option. Refer to "Part 3 – Execution" subsection of that same Division 23 section for an explanation of which specific material(s) shall be used for which specific application(s). For example, Part 2 may list several types and grades of piping, and Part 3 will describe which type and grade of pipe to use for a given application.

1.6 COORDINATION DRAWINGS

- A. Prepare project coordination drawings to a scale of $\frac{1}{4}" = 1'0"$ or larger. Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:
1. Planned piping layout, including valve and specialty locations and valve-stem movement. Include all piping including but not limited to HVAC piping, plumbing piping, and fire protection piping. Include ceiling and wall-mounted access doors and panels required to provide access to valves and other operating devices.
 2. Planned ductwork layout, including terminal units, dampers and specialty locations, with terminal unit and damper operator clearances. Include ceiling and wall-mounted access doors and panels required to provide access to dampers and other operating devices.
 3. Clearances for installing and maintaining insulation.
 4. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
 5. Equipment and accessory service connections and support details.
 6. Exterior wall and foundation penetrations.
 7. Fire-rated wall and floor penetrations.
 8. Sizes and location of required concrete pads and bases.
 9. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
 10. Floor plans, elevations, and details to indicate penetrations in floors, walls, ceilings and roofs, and their relationship to other penetrations and installations.
 11. Ceiling plans showing coordination of mechanical, electrical, structural, ceiling suspension assembly, lighting, security, communications, fire alarm, plumbing, and fire protection work within allotted space.
 12. Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, access panels, special moldings, and other ceiling-mounted items.
 13. Floor plans and sections of fan rooms and mechanical rooms; show layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.
 14. Contractor shall show all existing systems that are to remain as-is in coordination drawings, including but not limited to all existing piping, ductwork, electrical conduit and all junction boxes, fire protection, plumbing systems and HVAC system equipment. All existing systems shall be modeled to correct locations and coordinated with all new work.

1.7 ELECTRONIC MEDIA AND FILES

- A. Electronic media files of the contract drawings in AutoCAD or PDF format and copies of the specifications in PDF format may be requested.
- B. Complete and return a signed "Electronic File Transmittal" form provided by Introba upon request for electronic media.
- C. Obtain approval from the appropriate Design Professional for use of their part of the documents if the information requested includes information prepared by other than Introba.
- D. The electronic contract documents may be used for preparation of shop drawings and record drawings only. The information may not be used in whole or in part for any other project.
- E. The drawings prepared by Introba for bidding purposes may not be used directly for raceway layout drawings or coordination drawings.

- F. The use of these documents does not allow relief from the responsibility for coordination of work with other trades and verification of space available for the installation.
- G. The information is provided to expedite the project with no guarantee by Introba as to the accuracy or correctness of the information provided. Introba accepts no responsibility or liability for the use of the provided information.

1.8 RECORD DOCUMENTS

- A. Prepare record documents in accordance with the requirements in Division 01. In addition to the requirements specified in Division 01, indicate the following installed conditions:
 - 1. Ductwork mains and branches, size and location, for both exterior and interior; locations of dampers and other control devices; filters, boxes, and terminal units requiring periodic maintenance or repair.
 - 2. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Indicate actual inverts and horizontal locations of all underground piping.
 - 3. Valve location diagrams, complete with valve tag chart. Refer to Division 23 Section "Basic Mechanical Materials and Methods."
 - 4. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
 - 5. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
 - 6. Contract Modifications, actual equipment and materials installed.

1.9 MAINTENANCE MANUALS

- A. Prepare maintenance manuals in accordance with Division 01. In addition to the requirements specified in Division 01, 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.
 - 5. Facsimiles or photo copies are not allowed as submittals for operating and maintenance manuals. Submittals for operating and maintenance manuals must be on original manufacturer printed stock.
- B. In addition to the above, comply with ASHRAE Guideline 4-2008 (RA 2013) *Preparation of Operating and Maintenance Documentation for Building Systems*.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. During construction, meet or exceed the recommended Design Approaches of SMACNA *IAQ Guideline for Occupied Buildings under Construction*.
- B. Protect stored on-site or installed absorptive materials from moisture damage. Materials directly exposed to moisture via precipitation, water leaks, or condensation shall be removed from the jobsite and replaced.

END OF SECTION 23 0100

SECTION 23 0500 – BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following basic mechanical materials and methods to complement other Division 23 Sections:
 - 1. Materials and installation instructions common to mechanical systems.
 - 2. Pipe joining materials and methods.
 - 3. Dielectric Flange and Dielectric Waterway
 - 4. Flexible pipe connectors.
 - 5. Modular sleeve seals.
 - 6. Pipe sleeves.
 - 7. Penetration firestopping of fire-resistance-rated assemblies and/or smoke barriers by mechanical piping, conduit, or ductwork
 - 8. Labeling and identifying mechanical systems and equipment.
 - 9. Non-shrink grout for equipment installations.
 - 10. Painting and finishing of mechanical work.
 - 11. Concrete base construction requirements.
 - 12. Coordination with Structural work.
 - 13. Field-fabricated equipment supports.
 - 14. Selective Demolition.
 - 15. Cutting and patching.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 23 0100 "Basic Mechanical Requirements" applies to the work of this Section as if fully repeated herein.
- C. Pipe and pipe fitting materials are specified in individual Division 23 piping system Sections.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces (Laboratories) and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following abbreviations are used throughout Division 23 Specification Sections:
 - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
 - 2. CPVC: Chlorinated polyvinyl chloride plastic.
 - 3. CR: Chlorosulfonated polyethylene synthetic rubber.
 - 4. EPDM: Ethylene propylene diene terpolymer rubber.
 - 5. NBR: Acrylonitrile-butadiene rubber.
 - 6. NP: Nylon plastic.
 - 7. PE: Polyethylene plastic.
 - 8. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

- A. Product Data: For dielectric flanges, transition couplings, flexible pipe connectors, modular sleeve seals, and identification materials and devices.

- B. Shop Drawings: Detail fabrication and installation for supports and anchorage for mechanical materials and equipment.
- C. Coordination Drawings: For access panel and door locations.

1.5 QUALITY ASSURANCE

- A. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.
- B. Welding: Qualify welding processes and operators for structural steel according to AWS D1.1 "Structural Welding Code – Steel."
- C. Welding: Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions of ASME B31 Series "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current.
 - 3. Contactor shall retain all welding certificates on file and produce them for review upon request by the Owner and/or Owner's representative.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and prevent entrance of dirt, debris, and moisture. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor or roof, if stored thereupon. Protect flanges, fittings, and piping specialties from moisture and dirt.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.
- C. Protect ductwork interiors from the elements and foreign materials throughout construction. Deliver ducts with shop-applied impervious protective covering over all open ends. Maintain protective end coverings through shipping, storage, and handling to prevent entrance of dirt, debris, and moisture. Elevate stored ducts above grade. As ductwork is installed, remove protective end covering as each successive segment is connected, but with protective end covering maintained over open ends remaining exposed.
- D. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

1.7 SEQUENCING AND SCHEDULING

- A. Coordinate mechanical equipment installation with other building components.
- B. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.
- C. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.
- D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.
- E. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.
- F. Coordinate requirements for access panels and doors if mechanical items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Panels."
- G. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.
- H. Coordinate connection of electrical services.
- I. Unless otherwise noted, install all ductwork above all other systems. Coordinate with all other disciplines. Provide required access to duct mounted access doors and dampers.
- J. All work that will require shut down of existing utilities must be coordinated a minimum of seven (7) days in advance.
- K. The construction area of this project is adjacent to, above and below areas of this building which shall remain fully functional and operational throughout the project. Systems that serve other areas of this building currently are routed through this project construction boundaries.

- L. Any operation where high levels of noise are expected on the construction site will need to be coordinated and approved with the Owner's representative at least 48 hours prior to the work being initiated.
- M. Prior to beginning demolition, contact the Owner concerning removal of existing controllers, zone sensor and lab control valves so they are not damaged. Temperature sensors that are removed shall be turned over to the Owner. Reconnect the existing network bus wiring so communications are maintained. Contact the Owner concerning the bus routing. Splicing of wires is not allowed. Pull new wires if existing wires are too short. Remove all existing pneumatic tubing, related controls and all accessories made obsolete by the work of this project. Provide a brass compression cap type fitting at all unused pneumatic tubing terminations. Do not pinch-off tubing.
- N. The low-pressure steam shutdowns shall only be allowed when the outside air temperatures are to be above 65 degrees F for seven (7) consecutive days unless approved otherwise by the Owner's Representative.
- O. Heating hot water and chilled water shutdowns shall only be allowed after hours or weekends and must be approved by Owner's Representative a minimum of seven (7) days in advance.
- P. The existing exhaust air system (exhaust risers) within this building tie together on the roof to ganged fan systems. Shut down and temporarily capping and/or tying into an existing exhaust riser shall occur after 5pm or on weekends and must be scheduled with Owner's Representative a minimum of seven days in advance. All shutdowns are allowed for a maximum of a 12-hour period unless otherwise approved by the Owner's Representative.
- Q. Due to extensive occurrences of hazardous materials used in the original construction of the building (i.e lead paint and asbestos), the Contractor shall coordinate all demolition with the abatement Contractor. Efforts have been made to show the majority of this demolition on these and the architectural plans, but clearly, the exact location and extent of the demolition must be coordinated. See specification sections in division 02 existing conditions for requirements associated with the removal of hazardous materials.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Transition Couplings:
 - a. Dresser Industries, Inc.
 - b. or approved equal.
 - 2. Dielectric Flange:
 - a. Grinnell Corp.; Grinnell Supply Sales Co.
 - b. or approved equal.
 - 3. Dielectric Waterway:
 - a. Clearflow
 - b. Victaulic, Inc.
 - 4. Flexible Pipe Connectors:
 - a. Anvil International.
 - b. Flexicraft Industries, Inc.
 - c. Hyspan Precision Products, Inc.
 - d. Mason Industries, Inc.
 - e. The Metraflex Company
 - f. Proco Products, Inc.
 - 5. Modular Sleeve Seals:
 - a. Calpico, Inc.
 - b. Flexicraft Industries, Inc. "PipeSeal"

- c. GPT div. of EnPro Industries, Inc "Link-Seal"
- d. The Metraflex Company

6. Identifying Devices and Labels:

- a. Brady USA, Inc., Signmark Div.
- b. Brimar Industries, Inc.
- c. Kolbi Industries, Inc.
- d. Panduit Corp.
- e. Seton Name Plate Co.

2.2 PIPE AND PIPE FITTINGS

- A. Refer to individual Division 23 piping Sections for pipe and fitting materials and joining methods.

2.3 JOINING MATERIALS

- A. Refer to individual Division 23 piping Sections for special joining materials not listed below.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.
- C. Pipe-Flange Joining Gaskets: ASME B16.21, EPDM, flat, asbestos-free, 1/8-inch (3.2-mm) thickness, unless noted otherwise.
 - 1. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - 2. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- D. Pipe-Flange Joining Bolts and Nuts: ASME B18.2.1 bolts with ASME B18.2.2 nuts, carbon steel, unless otherwise indicated.
 - 1. Bolts and nuts shall be Type 304 or Type 316 stainless steel, if installed on stainless steel piping, and matching the grade of stainless steel piping.
 - 2. Bolts and nuts shall be Type 304 stainless steel if installed on uninsulated piping located outdoors.
- E. Solder Filler Metals: ASTM B32 lead-free alloys. Include water-flushable flux according to ASTM B813.
- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Solvent Cements: Manufacturer's standard solvent cements for the following:
 - 1. ABS Piping: ASTM D2235.
 - 2. CPVC Piping: ASTM F493.
 - 3. PVC Piping: ASTM D2564. Include primer according to ASTM F656.
 - 4. PVC to ABS Piping Transition: ASTM D3138.
- I. Plastic Pipe Seals: ASTM F477, elastomeric gasket.
- J. Flanged, Ductile-Iron Pipe Gasket, Bolts, and Nuts: AWWA C110, rubber gasket, carbon-steel bolts and nuts unless noted otherwise.
 - 1. Bolts and nuts shall be Type 304 stainless steel if installed on uninsulated piping located outdoors.
- K. Transition Couplings: Iron-body sleeve assembly, fabricated to match OD of plain-end, pressure pipes.
 - 1. Sleeve: ASTM A126, Class B, gray iron.
 - 2. Followers: ASTM A47 (ASTM A47M) malleable iron or ASTM A536 ductile iron.
 - 3. Gaskets: Rubber.
 - 4. Bolts and Nuts: AWWA C111.
 - 5. Finish: Enamel paint.

2.4 DIELECTRIC FLANGES

- A. Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, full-face type. Components shall include EPDM gasket, phenolic or polyethylene bolt sleeves designed to prevent any metal-to-metal contact across mating flanges; phenolic washers, and steel backing washers. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures. Copper pipe flange shall be soldered-on companion flange in sizes 3/4-inch and larger; steel pipe flange shall be threaded-on in sizes 3/4-inch to 2-inch. Other flanges and flange bolting kits are specified in "Joining Materials" subsection above.
- B. **DIELECTRIC NIBBLES ARE NOT ALLOWED. REFER TO 232113 HYDRONIC PIPING FOR ALLOWED SYSTEMS.**

2.5 DIELECTRIC WATERWAY

- A. Dielectric-Waterway: Field-assembled, companion-flange assembly, full-face type. Components shall include EPDM gasket, phenolic or polyethylene bolt sleeves designed to prevent any metal-to-metal contact across mating flanges; phenolic washers, and steel backing washers. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures. Copper pipe flange shall be soldered-on companion flange in sizes ¾-inch and larger;

2.6 FLEXIBLE PIPE CONNECTORS

- A. General: Fabricated from materials suitable for system fluid and that will provide equipment-pipe connections.
- B. General: Sometimes referred to as “flexible connectors” on Drawings. Fabricated from materials suitable for system fluid and that will provide pump pipe connections. Include 125-psig (860-kPa) minimum working-pressure rating, unless higher working pressure is indicated, and ends according to the following:
 - 1. 2-Inch NPS (DN50) and Smaller: Threaded.
 - 2. 2½-Inch NPS (DN65) and Larger: Flanged.
- C. Stainless-Steel-Hose/Stainless-Steel Pipe, Pump Connectors: Corrugated, stainless steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose.
- D. Active (Live) Length: 12 inches for nominal pipe sizes 2½ inches and smaller; 18 inches for nominal pipe sizes 3 – 4 inches; 24 inches for larger nominal pipe sizes. (Active or Live Length is end-to-end less total fitting length minimum.)
- E. Flexible pipe connectors specified herein are for use at the piping connection to a piece of mechanical equipment, including but not limited to pumps. These are not acceptable for use where “expansion joints” or “pipe expansion fittings” are called out. Refer to Division 23 Section “Pipe Expansion Fittings” for pipe expansion joints or pipe expansion fittings.

2.7 MODULAR SLEEVE SEALS

- A. Description: Modular design, with interlocking rubber links shaped to continuously fill annular space between pipe and sleeve. Include connecting bolts and pressure plates.
- B. Sealing Elements: Interlocking links of EPDM, shaped to fit surface of pipe. Include number and size of links required for size of pipe. Modular seal elements shall have a tensile strength of not less than 1200 psi per ASTM D412 test method.
- C. Pressure Plates: Select among reinforced nylon polymer, steel zinc dichromate, or stainless steel. Include two for each sealing element.
- D. Connecting Bolts and Nuts: Type 304 or 316 stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.
- E. Minimum Temperature Rating: -40°F to +210°F (-40°C to +99°C).

2.8 PIPE SLEEVES

- A. The following sleeve materials are for wall, floor, slab, and roof penetrations.
- B. Steel Pipe: ASTM A53, Type E, Grade A, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated “wall pipe” equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.
- E. Contractor's Option: Pre-engineered, UL-listed fire-resistance rated and watertight cast-in-place floor sleeving systems meeting the following specifications will be acceptable in lieu of traditional floor sleeves with field-installed firestop, at contractor's option.
 - 1. Description: Cast-in-place, factory-assembled, one-piece watertight firestop device for use in concrete floors formed with wood and/or steel decking to protect penetrating objects from expansion and contraction of concrete, thermal and seismic movement, and the passage of air, smoke, fire, and hot gasses.

2. Manufacturer: Subject to compliance with requirements, provide Hydroflame™ sleeving system by Hubbard Enterprises / Holdrite; or approved equal.
3. Include an outer sleeve lined with an intumescent strip; and a radial extended flange attached to one end of the sleeve for fastening to concrete formwork; or wide outside wings attached to one end of the sleeve for fastening to metal deck concrete formwork and span deck corrugations.
4. Include a waterstop gasket and mid-body seal consisting of one to three concentric raised rings for embedment and sealing to the concrete slab. For applications involving a corrugated deck, also include a cone attached to the base for extending the device through the metal deck.
5. Product shall provide a two-hour fire-resistance rated assembly when tested according to ASTM E814 or ANSI/UL 1479.

2.9 ESCUTCHEONS AND FLOOR PLATES

- A. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners. Use only for piping with a fitting or sleeve protruding from wall.
- B. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- C. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.
- D. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- E. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.10 PENETRATION FIRESTOPPING SYSTEMS

- A. Refer to Division 07 for all firestop products whose requirements apply to the work of Division 23 as if fully reproduced herein.

2.11 IDENTIFYING DEVICES AND LABELS

- A. General: Manufacturer's standard products of categories and types required for each application as referenced in other Division 23 Sections. If more than one type is specified for application, selection is installer's option, but provide one selection for each product category.
- B. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.
- C. Equipment Nameplates: Metal nameplate with operational data engraved or stamped; permanently fastened to equipment; furnished and factory-installed by original equipment manufacturer.
 1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data.
 2. Location: Accessible and visible location.
- D. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, permanent adhesive, color-coded, pressure-sensitive vinyl, complying with ASME A13.1.
 1. Nomenclature: Heating Water Supply, Heating Water Return, Chilled Water Supply, Chilled Water Return, Natural Gas, etc. as required per service. Match name to the name given on Drawings (full names, not abbreviations).
 2. Color: Per ASME A13.1 Standard per service, unless noted otherwise.
 3. Flow Direction: Indicate flow direction via arrows on each label.
 4. Pipe Size: Indicate nominal pipe size, in inches, on each label.
 5. Example: ←2" CHILLED WATER RETURN←
- E. Plastic Duct Markers: Manufacturer's standard color-coded, laminated plastic. Comply with the following color code:
 1. Green: Cold air.
 2. Yellow: Hot air.
 3. Yellow/Green or Green: Supply air.
 4. Blue: Exhaust, outside, return, and mixed air.
 5. For hazardous exhausts, use colors and designs recommended by ASME A13.1.
 6. Nomenclature: Include direction of airflow and duct service.
 7. Example: ←RETURN AIR←
- F. Engraved Plastic-Laminate Signs: ASTM D709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated.
 1. Fabricate in sizes required for message.
 2. Engraved with engraver's standard letter style, of sizes and with wording to match equipment identification.
 3. Punch for mechanical fastening.

4. Thickness: 1/16-inch (1.6 mm), for units up to 20 sq. in. (130 sq. cm) or 8 inches (200 mm) long; 1/8-inch (3.2 mm) for larger units.
 5. Fasteners: Self-tapping stainless-steel screws or contact-type permanent adhesive.
 6. Provide signs at all Fire / Fire-Smoke Dampers. Install at location unobstructed to view in rooms. Use numbers, lettering and wording as indicated on Fire / Fire-Smoke Damper sheets of Construction Documents.
- G. Valve Tags: Photo-anodized barcode tags with 1/4-inch (6-mm) letters and numbers. Include 5/32-inch (4-mm) hole for fastener.
1. Material: 0.032-inch (0.8-mm) thick anodized aluminum.
 2. Color: Silver background with black characters.
 3. Printed Nomenclature: Piping system abbreviation and sequenced number; e.g., CWS-23 for chilled water supply valve #23; HWR-12 for hot water return valve #12.
- H. Valve Tag Fasteners: Brass, wire-link chain or stainless-steel beaded chain.
- I. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in mechanical identification, with corresponding designations indicated. Use numbers, lettering, and wording indicated for proper identification and operation/maintenance of mechanical systems and equipment.
1. Multiple Systems: If multiple systems of same generic name are indicated, provide identification that indicates individual system number and service such as "Boiler No. 3," "Air Supply No. 1H," or "Standpipe F12."
- J. All systems that are abandoned do to work of this project shall be labeled "ABANDONED".

2.12 CONCRETE AND GROUT

- A. Concrete: For all minor concrete work required for mechanical installations, such as concrete equipment bases and supports, refer to Division 03 Sections for specification of cast-in-place concrete and reinforcing materials, whose requirements apply to the work of Division 23 as if fully reproduced herein.

2.13 PAINTING AND FINISHING

- A. For all painting and finishing work required for mechanical installations, as described in Part 3 of this Section and/or on the Drawings, refer to Division 09 Sections for specification of paint and finishing materials, whose requirements apply to the work of Division 23 as if fully reproduced herein.

PART 3 - EXECUTION

3.1 GENERAL MECHANICAL INSTALLATION REQUIREMENTS

- A. Verify all dimensions by field measurements.
- B. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
- C. 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.
- D. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
- E. Install mechanical 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. Extend grease fittings to an accessible location.
- F. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.2 PIPING SYSTEM INSTALLATION REQUIREMENTS

- A. General: Install piping as described below, unless piping Sections specify otherwise. Individual Division 23 piping Sections specify unique piping installation requirements.
- B. General Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, unless deviations to layout are approved on Coordination Drawings.
- C. Install components with pressure rating equal to or greater than system operating pressure.
- D. Install piping at indicated slope, and free of sags and bends.

- E. Install piping tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal. Install piping to allow application of insulation plus 1-inch (25-mm) clearance around insulation.
- F. Locate groups of pipes parallel to each other, arranged and spaced to permit valve servicing.
- G. Install fittings for changes in direction and branch connections. Install couplings according to manufacturer's written instructions.
- H. Install piping in concealed interior and exterior locations, except in equipment rooms and service areas. Install exposed interior and exterior piping at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.
- I. Electrical Equipment Spaces: Route piping to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- J. Piping Support: As specified in Division 23 Section "Hangers and Supports."

3.3 PIPING JOINING REQUIREMENTS

- A. Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping specification Sections.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Note internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
 - 2. Apply appropriate tape or thread compound to external pipe threads, unless dry seal threading is specified.
 - 3. Align threads at point of assembly.
 - 4. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
 - 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, "Recommended Practices and Procedures for Welding Low Carbon Steel Pipe," using qualified processes and welding operators according to "Quality Assurance" Article.
 - 1. Apply one coat of self-priming, rust-inhibitor paint around the entire circumference of each welded pipe joint; regardless of whether or not the piping is specified to be painted. Paint may be brush-applied, roller-applied, or spray-applied at contractor's option.
- H. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. ABS Piping: ASTM D2235 and ASTM D2661.
 - 3. CPVC Piping: ASTM D2846 and ASTM F493.
 - 4. PVC Pressure Piping: ASTM D2672.
 - 5. PVC Non-pressure Piping: ASTM D2855.
 - 6. PVC to ABS Non-pressure Transition Fittings: Procedure and solvent cement according to ASTM D3138.
- J. Piping Connections: Make connections according to the following, unless otherwise indicated.
 - 1. Install unions, in piping 2-inch NPS (DN50) and smaller at final connection to each piece of equipment with 2-inch NPS (DN50) or smaller threaded pipe connection.

2. Install flanges, in piping 2½-inch NPS (DN65) and larger, adjacent to flanged valves and at final connection to each piece of equipment with flanged pipe connection.
3. Install dielectric flanges to connect piping materials of dissimilar metals.
4. Valve Caps: Any valve that represents a termination or the end of a run (e.g., blowdown or drain valve, hose-end valve, etc.) shall be fitted with a permanent but removable cap, plug, or blind flange matching the valve construction, to minimize risk in the event the valve is accidentally opened under pressure.

3.4 PIPE-PENETRATION INSTALLATION REQUIREMENTS

- A. Except as noted otherwise, install escutcheons for both insulated and bare piping in the following cases:
 1. New piping of penetrations of newly-constructed walls, ceilings, and floors.
 2. New piping penetrations of existing walls, ceilings, and floors.
 3. Existing piping which penetrates newly-constructed walls, ceilings, and floors.
- B. Escutcheons are not required in the following cases. Note that some form of closure of the annular or overcut opening (for reasons of acoustics, fire/smoke, sight, etc.) may still be required by other provisions of these documents.
 1. Existing piping which penetrates existing walls, ceilings, and floors.
 2. Wall penetrations in an unfinished cavity above a finished ceiling.
 3. Penetrations of a wall or partition dividing one unfinished space from another unfinished space, such as service spaces, storage rooms, and equipment rooms.
- C. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening. Use one-piece type for new piping and split-plate type for existing piping as specified in Part 2 of this section.
- D. Install floor plates for piping penetrations of unfinished floors in service spaces and equipment rooms. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening. Use one-piece floor-plate type for new piping and split-casting floor-plate type for existing piping as specified in Part 2 of this section.
- E. Install sleeves for pipes passing through concrete and masonry walls, and concrete floor and roof slabs.
- F. Cut sleeves to length for mounting flush with both surfaces. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
- G. Fire-Resistance Rated, Cast-in-Place Sleeve Installation: Select sleeve size based on size and type of pipe and thickness of the floor. Position and secure sleeve to concrete form using nails or staples. Place concrete and finish even with top of sleeve. Install in complete and strict accordance with manufacturer's UL-listed installation instructions.
- H. Build sleeves into new walls and slabs as work progresses.
- I. Install sleeves large enough to provide ¼-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 1. Steel Pipe Sleeves: For pipes smaller than 6-inch NPS (DN150).
 2. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 07 Section "Flashing and Sheet Metal" for flashing.
 3. Seal space outside of sleeve fittings with non-shrink, non-metallic grout.
- J. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using elastomeric joint sealants. Refer to Division 07 Section "Joint Sealants" for materials. Use Type S, Grade NS, Class 25, Use O, neutral-curing silicone sealant, unless otherwise indicated.
- K. Aboveground, Exterior-Wall, Pipe Penetrations: Seal penetrations using sleeves and modular sleeve seals. Size sleeve for 1-inch (25-mm) annular clear space between pipe and sleeve for installing modular sleeve seals.
 1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
 2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) in diameter and larger.
 3. Assemble and install modular sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber-sealing elements to expand and make watertight seal.
- L. Underground, Exterior-Wall, Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using modular sleeve seals. Size sleeve for 1-inch (25-mm) annular clear space between pipe and sleeve for installing modular sleeve seals. Assemble and install modular sleeve seals according

to manufacturer's written instructions. Tighten bolts that cause rubber-sealing elements to expand and make watertight seal.

- M. Sleeves are not required for core-drilled holes.
- N. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestopping materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

3.5 EQUIPMENT INSTALLATION REQUIREMENTS

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected. Refer to equipment specifications in Division 23 and Division 26 for rough-in requirements.
- B. Install equipment to provide maximum possible headroom, if mounting heights are not indicated.
- C. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to Architect.
- D. Positive attachment and anchorage of all equipment to the structure or floor is required. Do not rely on friction or gravity as a means of attachment.
- E. Install flexible pipe connectors at the following locations. Install on equipment side of shutoff valves.
 - 1. Inlet and outlet of each pump.
 - 2. Inlet and outlet of each chiller.
 - 3. At each connection to a packaged computer-room air-conditioning unit.
 - 4. Where indicated elsewhere in these specifications.
 - 5. Where detailed on the Drawings.
- F. Support for Suspended Equipment: As specified in Division 23 Section "Hangers and Supports."

3.6 LABELING AND IDENTIFYING

- A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow. Use plastic markers, with application systems.
 - 1. Install on insulation segment if required for hot, uninsulated piping.
 - 2. Install directional arrows around the pipe on both ends of pipe identification label, overlapping label slightly to help secure label to pipe.
 - 3. If directional arrows are not applicable, install adhesive tape matching pipe or insulation color on both ends to help secure pipe identification label.
- B. Locate pipe markers as follows if piping is exposed in finished spaces, machine rooms, and accessible maintenance spaces, such as shafts, tunnels, plenums, and exterior non-concealed locations:
 - 1. Near each valve and control device.
 - 2. Near each branch, excluding short takeoffs for fixtures and terminal units. Mark each pipe at branch, if flow pattern is not obvious.
 - 3. Near locations where pipes pass through walls, floors, ceilings, or enter non-accessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum of 50-foot (15-m) intervals along each run. Reduce intervals to 25 feet (7.5 m) in congested areas of piping and equipment.
 - 7. On piping above removable acoustical ceilings, except omit intermediately spaced markers.
- C. Install continuous plastic underground warning tapes during back filling of trenches for underground piping. Locate 6 to 8 inches (150 to 200 mm) below finished grade, directly over piping. Refer to Division 31 Section "Earth Moving" for warning-tape materials and devices and their installation.
- D. Equipment: Install engraved plastic-laminate sign on or near each major item of mechanical equipment.
 - 1. Lettering Size: Minimum ¼-inch- (6.4-mm-) high lettering for name of unit if viewing distance is less than 24 inches (610 mm), ½-inch- (12.7-mm-) high lettering for distances up to 72 inches (1800 mm), and proportionately larger lettering for greater distances. Provide secondary lettering two-thirds to three-fourths of size of principal lettering.
 - 2. Text of Signs: Provide name of identified unit. Include text to distinguish between multiple units, inform user of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
- E. Duct Systems: Identify air supply, return, exhaust, intake, and relief ducts with duct markers showing duct system service and direction of flow. In each space, if ducts are exposed or concealed by removable ceiling system, locate signs near points where ducts enter into space and at maximum intervals of 50 feet (15 m).

- F. Adjusting: Relocate identifying devices as necessary for unobstructed view in finished construction.
- G. Install valve tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, plumbing fixture supply stops, faucets, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units.

3.7 PAINTING AND FINISHING

- A. For all painting and finishing work required for mechanical installations, refer to Division 09 Sections for application requirements.
- B. Painting HVAC Work: Paint the following work where exposed to view in finished or unfinished spaces: Uninsulated steel piping, pipe hangers and supports, tanks that do not have factory-applied final finishes, all interior and exterior ferrous piping and appurtenances, including steel, galvanized steel, cast iron and ductile iron.
- C. In addition, paint the following:
 - 1. Duct, equipment, and pipe insulation having ASJ or other paintable jacket material.
 - 2. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.
- D. Steel Substrates: Primer, alkyd, anti-corrosive, for metal, MPI #79; plus topcoat of latex, interior, semi-gloss, MPI #54.
- E. Galvanized-Metal Substrates: Primer, galvanized, water based, MPI #134; plus topcoat of latex, interior, semi-gloss, MPI #54.
- F. Aluminum (Not Anodized or Otherwise Coated) Substrates: Primer, quick dry, for aluminum, MPI #95; plus topcoat of latex, interior, semi-gloss, MPI #54.
- G. ASJ Insulation-Covering Substrates: Including pipe and duct coverings. Primer sealer, latex, interior, MPI #50; plus topcoat of latex, interior, semi-gloss, MPI #54.
- H. Primers specified above may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

3.8 CONCRETE BASES

- A. Anchor equipment to concrete base according to equipment manufacturer's written instructions.
- B. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
- C. 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 the base.
- D. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
- E. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
- F. Install anchor bolts according to anchor-bolt manufacturer's written instructions. Install anchor bolts to elevations required for proper attachment to supported equipment.
- G. When anchoring equipment that is installed on neoprene or rubber vibration isolator pads, the anchor bolt shall include a neoprene or rubber grommet placed between the nut and the equipment frame so as not to short-circuit the vibration isolation provided by the neoprene pad. An example of one such device is Model GW Grommet Washers by Vibro-Acoustics, a Swegon Group company.
- H. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 03.

3.9 COORDINATION WITH STRUCTURAL WORK

- A. Concrete: Do not embed pipes, wires, tube, boxes, ducts or other cavity-creating elements in concrete work unless shown on or permitted by the structural drawings. Openings through concrete not shown on the structural drawings are subject to approval by the structural engineer of record. See coordination drawing requirements under Submittals.
- B. Roof Deck: Do not place loads on, or hang any loads whatsoever from roof deck, unless shown on structural drawings, including, but not limited to, hangers for pipes, ducts, equipment, etc. Trade contractor installing such loads shall provide sub-framing connected to steel frame.
 - 1. Do not exceed capacity of roof deck as a working platform. Submit all proposed construction loads to deck supplier for approval.

2. Openings in roof deck not shown on structural drawings, such as openings required for stacks, pipes, ducts, plumbing vents, etc., shall be cut and reinforced by trade requiring opening.
- C. Supported Slab: Do not suspend loads exceeding 500 pounds within any 100 square feet of contiguous area from concrete supported slab. Suspend such loads from structural steel only. Any "sub-framing" required is responsibility of Contractor or sub-contractor installing material requiring support.
 1. Openings in concrete floor slabs not shown on structural drawings, such as openings required for stacks, pipes, ducts, plumbing vents, etc., shall be the responsibility of the trade requiring openings. Form blockouts in the slab, reinforcing deck, and cut openings after concrete has reached specified strength.
 2. Where openings larger than 12-inches are required but not shown on structural drawings, secure written approval from Architect/Engineer prior to cutting deck.

3.10 ERECTION OF SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- B. Field Welding: Comply with AWS D1.1, "Structural Welding Code – Steel."

3.11 SELECTIVE DEMOLITION

- A. Disconnect, demolish, and remove mechanical work as indicated on the Drawings, and as required for installation of new work shown. Coordinate with Division 26 for disconnection of power to electrically-powered equipment prior to demolition.
- B. Remove accessible work in its entirety. Repair cut surfaces to match adjacent surfaces. Abandon in place embedded or buried work, unless noted otherwise.
 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 2. DO NOT ABANDON ANY PIPING IN PLACE UNLESS APPROVED BY ENGINEER AND OWNER'S REPRESENTATIVE IN WRITING.
 3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
 4. DO NOT ABANDON ANY DUCTWORK IN PLACE UNLESS APPROVED BY ENGINEER AND OWNER'S REPRESENTATIVE IN WRITING.
 5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
- C. Removal: Unless otherwise indicated, remove demolished pipe, duct and equipment from the Project site. Handle and dispose of in accordance with National, State, and Local regulations.
 1. Relocation: Remove, store, clean, reinstall, reconnect, and make operational all work indicated for relocation.
 2. Salvage: Remove and deliver to Owner all work indicated for salvage.
- D. Refer to Division 01 Sections "Selective Demolition" and/or "Selective Structure Demolition" for additional requirements.
- E. For selective demolition of any appliance or piece of equipment containing a CFC, HCFC, or HFC refrigerant: Prior to demolition, refrigerant shall be evacuated and captured in full compliance with the Clean Air Act; using only technicians with the proper refrigerant license as according to law, stored in approved containers, and shipped to a licensed refrigerant recycling facility all as required by the United States Environmental Protection Agency.
- F. Demolish all equipment, pneumatic controls, piping, ductwork, etc. made obsolete by work of this project, in its entirety, including all hangers and supports. Do not leave piping, ductwork, controls, pneumatic tubing, supports, hangers or any other mechanical systems abandoned in place unless specifically noted by the design engineer.
- G. Owner shall maintain all salvage rights of equipment and materials removed. All equipment and materials not claimed by the Owner shall be removed from the premises by this Contractor.
- H. All existing temperature controls that are being demonstrated or disabled as work of this contract shall be completely removed from the building.

3.12 CUTTING AND PATCHING

- A. General: Employ skilled workmen to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time and complete without delay. Perform cutting and patching in accordance with the following:
- B. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

- C. Perform cutting, fitting, and patching of mechanical equipment and materials required to:
 - 1. Uncover Work to provide for installation of ill-timed Work.
 - 2. Remove and replace defective Work.
 - 3. Remove and replace Work not conforming to requirements of the Contract Documents.
 - 4. Install equipment and materials in existing structures.
- D. Cut, remove and legally dispose of selected mechanical equipment, components, and materials as indicated, including but not limited to removal of mechanical piping, pumps, and other mechanical items made obsolete by the new Work.
- E. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of trades involved.
- F. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
- G. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
- H. Repair cut surfaces to match adjacent installations.
- I. Repair any building insulation or building fireproofing materials, whether new or existing, that are removed or scraped away in order to make a mechanical installation, so as to maintain an equivalent insulation or fire rating as existed without said mechanical installation.
- J. Refer to Division 01 Sections "Execution" and/or "Cutting and Patching" for additional requirements.

3.13 GROUTING

- A. Install nonmetallic, non-shrink, grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Mix grout according to manufacturer's written instructions. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Place grout, completely filling equipment bases. Avoid air entrapment during placing of grout. Place grout on concrete bases to provide smooth bearing surface for equipment. Place grout around anchors.
- E. Cure placed grout according to manufacturer's written instructions.

END OF SECTION 23 0500

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SECTION 23 0513 – MOTORS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes basic requirements for factory-installed motors associated with mechanical equipment specified elsewhere in Division 23.
- B. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 23 0100 "Basic Mechanical Requirements," and Section 23 0500 "Basic Mechanical Materials and Methods" all apply to the work of this Section as if fully repeated herein.
- C. Related Sections include all other Division 23 Sections for application of motors and reference to specific motor requirements for motor-driven equipment.

1.3 DEFINITIONS

- A. Factory-Installed Motor: A motor installed by motorized-equipment manufacturer as a component of equipment.
- B. ECM: Electrically-commutated motor.
- C. ODP: Open drip-proof.
- D. TEFC: Totally-enclosed, fan-cooled.

1.4 SUBMITTALS

- A. Product Data: Submit motor product data with each associated equipment submittal. Show nameplate data and ratings; characteristics; mounting arrangements; size and location of winding termination lugs, conduit entry, and grounding lug; and coatings.

1.5 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. UL Listing: Motors specified in this Section must be listed and labeled by Underwriters Laboratories and bear the UL logo.

1.6 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices and features that comply with the following:
 - 1. Compatible with magnetic controllers, multi-speed controllers, and/or reduced-voltage controllers where applicable.
 - 2. Designed and labeled for use with variable frequency controllers where applicable and suitable for use throughout speed range without overheating.
 - 3. Matched to torque and horsepower requirements of the load.
 - 4. Matched to ratings and characteristics of supply circuit and required control sequence.
- B. Coordinate motor support with requirements for driven load; access for maintenance and motor replacement; installation of accessories, belts, belt guards; and adjustment of sliding rails for belt tensioning.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide motors by one of the following:
 - 1. Baldor Electric Co.
 - 2. Century Electric Co.
 - 3. General Electric Co.
 - 4. MagneTek
 - 5. Marathon Electric Mfg. Co.

6. Reliance Electric Co.
7. Siemens Energy & Automation, Inc.

2.2 BASIC MOTOR REQUIREMENTS

- A. Basic requirements apply to all types of mechanical equipment motors, unless otherwise indicated.
 1. Motors ½ HP and Larger: Polyphase.
 2. Motors Smaller than ½ HP: Single phase.
 3. Frequency Rating: 60 Hz.
- B. Voltage Rating: NEMA standard voltage selected to operate on nominal voltage of circuit to which motor is connected.
- C. Service Factor: According to NEMA MG 1, unless otherwise indicated, but at least 1.15 polyphase motors and 1.35 for single-phase motors.
- D. Duty: Continuous duty at ambient temperature of 104°F (40°C) and at altitude of 3300 feet (1000 meters) above sea level.
- E. Capacity and Torque Characteristics: Rated for continuous duty and sufficient to start, accelerate, and operate connected loads at designated speeds, in indicated environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
- F. Enclosure: ODP, unless otherwise indicated.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design E, medium induction motor, unless otherwise indicated.
 1. Stator: Copper windings, unless otherwise indicated.
 2. Rotor: Random-wound, squirrel cage, unless otherwise indicated.
 3. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
 4. Temperature Rise: Match insulation rating, unless otherwise indicated.
 5. Insulation: Class F, unless otherwise indicated.
- B. Code Letter Designation: Motors 15 HP and larger shall be NEMA starting Code F or Code G. Motors under 15 HP shall have manufacturer's standard starting characteristics.
- C. Enclosure: Cast iron for motors 7½ HP and larger; rolled steel for motors smaller than 7½ HP; with enamel finish.
- D. Efficiency: Motor efficiencies for motors one horsepower and greater shall in no case shall be less efficient than "Premium Efficiency" as defined in NEMA MG 1-2014 *Motors and Generators*. Motors shall be tested and labeled in accordance with NEMA MG 1-2014 Standard. Motor nameplate labeling shall include both the minimum and nominal efficiency.
- E. Motors Used with Reduced-Inrush Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- F. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 1. Designed with critical vibration frequencies outside operating range of controller output.
 2. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 3. Temperature Rise: Matched to rating for Class B insulation.
 4. Insulation: Class F or H.
 5. Motor shall be inverter-duty or inverter-ready and shall not require the use of external cooling fans.
- G. Shaft Grounding Ring: On any and all motors to be controlled by a Variable Frequency Motor Controller, include an engineered ring consisting of two or more rows of circumferential conductive microfibers to redirect shaft current and provide a low-impedance path from shaft to frame, bypassing the motor bearings. Factory-install on the motor shaft by sliding the ring over either end, and lock it in place with mechanically-fastened mounting brackets. Motors over 100 nameplate horsepower shall be provided with an insulated bearing on the non-drive end and a shaft grounding ring on the drive end of the motor. Product shall be "Aegis SGR" by Electro Static Technology no substitutions.
- H. Multispeed Motors: Variable torque.
 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 2. For motors with other than 2:1 speed ratio, separate winding for each speed.

I. Source Quality Control: Perform the following routine tests according to NEMA MG 1:

1. Measurement of winding resistance.
2. No-load readings of current and speed at rated voltage and frequency.
3. Locked rotor current at rated frequency.
4. High-potential test.
5. Alignment.

2.4 SINGLE-PHASE MOTORS

- A. Type: As indicated or selected by manufacturer from one of the following, to suit starting torque and other requirements of specific motor application.
1. Permanent-split capacitor.
 2. Split-phase start, capacitor run.
 3. Capacitor start, capacitor run.
- B. Shaded-Pole Motors: Do not use, unless motors are smaller than 1/20 hp.
- C. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- D. Thermal Protection: Where indicated or required, internal protection shall automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal protection device shall automatically reset when motor temperature returns to normal range, unless otherwise indicated.
- E. Bearings: Ball-bearing type for belt-connected motors and other motors with high radial forces on motor shaft. Sealed, pre-lubricated sleeve bearings for other single-phase motors.

2.5 ELECTRICALLY-COMMUTATED MOTORS

- A. General: Electrically-Commutated Motors are required wherever indicated in other Division 23 Specifications and/or notations on the Drawings.
- B. Motor: Motor shall be ECM, variable-speed, DC type, brushless motor designed for fan applications with heavy duty permanently lubricated ball bearings and electric commutation. It shall contain internal circuitry that converts single phase power into a DC signal. Motor shall be designed for direct-drive applications.
- C. Speed Control: The ECM shall be speed-controllable down to 10% of full speed via exterior-mounted field-adjustable potentiometer dial or DDC control signal input.
- D. Efficiency: Minimum 70% at all speeds.
- E. Voltage: Single-phase 115-V, 208-V, or 277-V as indicated.
- F. Rotor: Synchronous; permanent magnet type; built-in soft start.
- G. Thermal Protection: Where indicated or required, internal protection shall automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal protection device shall automatically reset when motor temperature returns to normal range, unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION, ALL MOTORS

- A. Use adjustable motor mounting bases for belt-driven motors. Align motors, bases, shafts, pulleys, and belts. Tension belts according to manufacturer's written instructions. Verify bearing lubrication.
- B. Run each motor with its controller. Demonstrate correct rotation, alignment, and speed at motor design load. Test interlocks and control and safety features for proper operation. Verify that current and voltage for each phase comply with nameplate rating and NEMA MG 1 tolerances.
- C. Correct malfunctioning motors on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new motors and retest.

END OF SECTION 23 0513

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SECTION 23 0519 – METERS AND GAGES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes manually-read and locally-read meters and gages listed below. Electronic meters that connect to a digital control system are specified in Division 23 Section "HVAC Instrumentation and Controls."
 - 1. Liquid-in-glass thermometers.
 - 2. Light-activated thermometers.
 - 3. Thermowells.
 - 4. Pressure gages.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 23 0100 "Basic Mechanical Requirements," and Section 23 0500 "Basic Mechanical Materials and Methods" all apply to the work of this Section as if fully repeated herein.
- C. The following Sections contain requirements that relate to this Section:
 - 1. Division 23 Section "Control Systems" for flow meters measuring water, air, steam, and/or condensate flow.
- D. Meters, thermometers and gages furnished as part of factory-fabricated equipment are specified as part of the equipment assembly in other Division 23 Sections.
- E. This Section does not include meters and gages associated with a building energy management or control system; those devices are specified in Division 23 Section "Control Systems."

1.3 SUBMITTALS

- A. Product Data: Submit product data for each type of meter, gage, and fitting specified. Include scale range, ratings, and calibrated performance curves. Submit a meter and gage schedule showing manufacturer's figure number, scale range, location, and accessories for each meter and gage.
- B. Product Certificates: For each type of meter and gage, from manufacturer.
- C. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Comply with applicable portions of American Society of Mechanical Engineers (ASME) and Instrument Society of America (ISA) standards pertaining to construction and installation of thermometers and gages.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Thermometers and Pressure Gages:
 - a. Ernst Gage Co.
 - b. Marsh Bellofram.
 - c. Miljoco Corp.
 - d. H.O. Trerice Co.
 - e. Weiss Instruments, Inc.
 - f. Weksler Glass Thermometer Corp.

2.2 THERMOMETERS

- A. Liquid-In-Glass Thermometers: ASME B40.200.
 - 1. Case: Cast aluminum; 9-inch (229-mm) nominal size unless otherwise indicated.
 - 2. Case Form: Adjustable angle; 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device
 - 3. Tube: Glass with magnifying lens and blue organic mineral spirit fill.
 - 4. Tube Background: Non-reflective aluminum with enameled scale markings graduated in both degrees F and degrees C.
 - 5. Window: Glass, acrylic, or Lexan.
 - 6. Stem: Stainless steel for separable socket, and of length to suit installation.
 - 7. Connector: 1¼ inches (32 mm), with ASME B1.1 screw threads.

8. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.
 9. Scale range, Heating Hot Water: 30°F to 240°F, with 2-degree scale divisions
 10. Scale range, Chilled Water: 0°F to 100°F, with 1-degree scale divisions.
 11. Scale range, Steam and Steam-Condensate Piping: 50 to 400°F, with 5-degree scale divisions.
 12. Scale range, Air Ducts: -40 to +160°F, with 2-degree scale divisions.
 13. Duct-Thermometer Mounting Brackets: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.
 14. Design for Air-Duct Installation: With ventilated shroud.
 15. Design for Thermowell Installation: Bare stem.
- B. Thermowells: ASME B40.200; Pressure-tight, socket-type fitting with protective dry well made for insertion into piping threaded tee fitting.
1. Material for Use with Copper Tubing: Brass.
 2. Material for Use with Steel Piping: Stainless steel.
 3. Type: Stepped shank unless straight or tapered shank is indicated.
 4. External Threads: NPS ½, NPS ¾, or NPS 1, (DN 15, DN 20, or DN 25) ASME B1.20.1 pipe threads.
 5. Internal Threads: ½, ¾, and 1 inch (13, 19, and 25 mm), with ASME B1.1 screw threads.
 6. Bore: Diameter required to match thermometer bulb or stem.
 7. Insertion Length: Length required to match thermometer bulb or stem, to extend to center of pipe.
 8. Lagging Extension: Nominal thickness of 2 inches, but not less than thickness of insulation. Omit extension neck for wells for piping not insulated.
 9. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
 10. Cap: Threaded, with chain permanently fastened to socket.
 11. Heat-Transfer Medium: Oil, conductive jelly, or mixture of graphite and glycerin.

2.3 PRESSURE GAGES

- A. Description: ASME B40.1, Grade A phosphor-bronze Bourdon-tube pressure gage with bottom connection; dry type, unless liquid-filled-case type is indicated.
1. Pressure gages serving pump differential measurement shall be liquid-filled.
 2. Case: Drawn steel, brass, or aluminum with 4½-inch-diameter glass lens.
 3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
 4. Pressure Connection: Brass, with NPS ¼ (DN 8), ASME B1.20.1 pipe threads.
 5. Movement: Mechanical, with link to pressure element and connection to pointer.
 6. Dial: Non-reflective aluminum with enameled scale markings graduated in dual units of psi and kPa.
 7. Pointer: Dark-colored metal.
 8. Window: Glass, acrylic, or Lexan lens.
 9. Ring: Brass or Stainless steel.
 10. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.
 11. Range (Fluids under Pressure): 0 to 160 psi.
- B. Gage Attachments:
1. Snubbers: ASME B40.100, brass; with NPS ¼ (DN 8), ASME B1.20.1 pipe threads and porous-metal-type surge-dampening device of material suitable for system fluid and working pressure. Include extension for use on insulated piping.
 2. Siphons: Loop-shaped section of brass or stainless-steel pipe with NPS ¼ (DN 8) pipe threads.
 3. Valves: Brass or stainless-steel needle-type, with NPS ¼ (DN 8), ASME B1.20.1 pipe threads. Ball valves are not acceptable.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install thermowells in vertical position in piping tees. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes. Install thermowells with extension on insulated piping. Fill thermowells with heat-transfer medium. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- B. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.
- C. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- D. Install valve and snubber in piping for each pressure gage for fluids (except steam).

- E. Install valve and siphon fitting in piping for each pressure gage for steam.
- F. Install thermometers in the following locations:
 - 1. Inlet and outlet of each hydronic coil in air-handling units.
 - 2. Outside-, return-, supply-, and mixed-air ducts.
- G. Install pressure gages in the following locations:
 - 1. Discharge of each pressure-reducing valve.
 - 2. Multiple points at each pump as detailed on Drawings; include trumpet valve. Pressure gages serving pump differential measurement shall be liquid-filled and shall include snubber.
 - 3. Where indicated on Drawings.
- H. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.
- I. After installation, calibrate meters according to manufacturer's written instructions. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION 23 0519

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SECTION 23 0523 – VALVES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following general-duty valves common to Division 23 mechanical piping systems:
 - 1. Ball valves.
 - 2. Butterfly valves.
 - 3. Check valves.
 - 4. Chainwheel actuators.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 23 0100 "Basic Mechanical Requirements," and Section 23 0500 "Basic Mechanical Materials and Methods" all apply to the work of this Section as if fully repeated herein.
- C. The following Sections contain requirements that relate to this Section:
 - 1. Division 02 piping Sections for general-duty and specialty valves for site construction piping.
 - 2. Division 21 fire-suppression piping and fire pump Sections for fire-protection valves.
 - 3. Division 23 Section "Basic Mechanical Materials and Methods" for valve tags and charts.
 - 4. Division 23 Section "Control Systems" for control valves and actuators.
 - 5. Division 23 piping Sections for specialty valves applicable to those Sections only.
- D. Valves for natural gas service, chemical treatment, refrigerant, medical gases, fire protection, and other specialty services are specified in their respective piping Section.

1.3 DEFINITIONS

- A. The following are standard abbreviations for valves used in this Section:
 - 1. CWP: Cold working pressure (formerly WOG – Water, Oil, Gas working pressure).
 - 2. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 3. OS&Y: Outside screw and yoke
 - 4. PTFE: Polytetrafluoroethylene plastic.
 - 5. SWP: Steam working pressure.
 - 6. TFE: Tetrafluoroethylene plastic.
 - 7. Class 125: Minimum 125-psig (860-kPa) SWP and minimum 200-psig (1380-kPa) CWP ratings.
 - 8. Class 150: Minimum 150-psig (1035-kPa) SWP and minimum 300-psig (2070-kPa) CWP ratings.

1.4 SUBMITTALS

- A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.
- B. Maintenance Data: For each type of valve, to include in the operation and maintenance manual specified in Division 01. Include detailed manufacturer's instructions on adjusting, servicing, disassembling, and repairing.

1.5 QUALITY ASSURANCE

- A. ASME Compliance: ASME B31.9 for building services piping valves.
- B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.
- C. MSS Compliance: Comply with the various MSS Standard Practice documents referenced herein.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, and weld ends.
 - 3. Set gate, and globe valves closed to prevent rattling.
 - 4. Set ball valves open to minimize exposure of functional surfaces.
 - 5. Set butterfly valves closed or slightly open.
 - 6. Block check valves in either closed or open position.

- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. General: Subject to compliance with requirements, provide gate valves, globe valves, and swing check valves by one of the following:
 - 1. Crane Co.; Crane Valve Group; Crane, Jenkins, & Stockham brands.
 - 2. Grinnell Corporation.
 - 3. Hammond Valve.
 - 4. Milwaukee Valve Company.
 - 5. NIBCO Inc.
 - 6. Red-White Valve Corp.
 - 7. Watts Industries, Inc.; Water Products Div.
 - 8. Victaulic Co.
- B. Ball Valves: Subject to compliance with requirements, provide ball valves by one of the following:
 - 1. Any of the manufacturers listed under the "General" subheading above.
 - 2. Conbraco Industries, Inc.; Appollo Division
 - 3. Johnson Control Inc.
 - 4. Griswold Co.
 - 5. Nexus
 - 6. Victaulic Co.
- C. Standard-Performance Butterfly Valves: Subject to compliance with requirements, provide butterfly valves by one of the following:
 - 1. Any of the manufacturers listed under the "General" subheading above.
 - 2. Bray International, Inc.
 - 3. Crane Co.; Crane Valve Group; Center Line brand.
 - 4. General Signal; DeZurik Unit
 - 5. McWane, Inc.; Kennedy Div.
 - 6. Metraflex Co.
 - 7. Grinnel
 - 8. Victaulic Co.
- D. Wafer Check Valves: Subject to compliance with requirements, provide butterfly-style dual-plate wafer check valves and piston-style lift-disc check valves by one of the following:
 - 1. Any of the manufacturers listed under the "General" subheading above.
 - 2. Metraflex Co.

2.2 VALVES, COMMON REQUIREMENTS

- A. General: Refer to Part 3 "Valve Applications Schedule" Article for application schedule of valves, end connections, and actuator types.
- B. Valve Sizes: Same as upstream pipe size, unless otherwise indicated.
- C. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.
- D. Valve Threaded Ends: With threads according to ASME B1.20.1.
- E. Valve Bypass and Drain Connections: MSS SP-45.
- F. Material Substitution: Ductile iron is acceptable anywhere cast iron is specified, but cast iron is not acceptable where ductile iron is specified.
- G. Class Substitution: If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.
- H. Chainwheel Operators: Where required, provide valve actuation assembly with ductile iron sprocket rim, brackets, and hot-dip galvanized steel chain; of type, number, size and fasteners as required for the host valve.

- I. For piping systems required to be insulated, valve stems shall be extended to accommodate insulation. Refer to other Division 23 Sections for piping systems required to be insulated.

2.3 BALL VALVES

- A. Liquid Service, Size NPS 2 (DN 50) and smaller:
 1. General: Valve shall conform to MSS SP-110.
 2. Minimum SWP rating: 150-psig (1035-kPa).
 3. Minimum CWP rating: 600-psig (4140-kPa).
 4. Body: ASTM B584 bronze, two-piece construction.
 5. Ball: Type 316 stainless steel, full port.
 6. Stem: Blowout-proof Type 316 stainless steel.
 7. Seat/Packing: PTFE or TFE.
 8. Ends: Threaded.
 9. Handle: Provide insulated extension handle to prevent condensation and other extraneous moisture from entering the insulated pipe system. Handle shall incorporate memory stop feature that requires no disassembly or removal of the handle to engage and make adjustments.
 - a. Housing: Fire Resistant ABS.
 - b. Sleeve: Fire Resistant ABS.
 - c. Cap: Polyethylene
 - d. Insulation Insert: Polystyrene
 - e. Shield: Plastic Sleeve
 - f. Lock Washer: Stainless Steel
 - g. Stop Plate & Screws: Stainless Steel
 - h. Memory Stop Assembly: Stainless Steel.

2.4 STANDARD-PERFORMANCE BUTTERFLY VALVES

- A. General: Valve shall conform to MSS SP-67, Type I.
- B. Minimum CWP rating: 175-psig (1207-kPa).
- C. Body and bonnet: ASTM A536 ductile-iron, extended neck. Cast iron valves will be rejected.
- D. Packing: Field-replaceable EPDM sleeve and stem seals.
- E. Stem and Stem Hardware: Type 316 stainless steel.
- F. Disc: Aluminum bronze or Type 316 stainless steel.
- G. End Connections: Lug and flanged bodies are acceptable; wafer bodies are not acceptable.
- H. Dead End Service: All butterfly valves shall be suitable for bi-directional dead-end service without downstream blind flange. Bolt holes on lugged valve bodies shall be threaded per ANSI B-1.1 coarse thread, with center stop, to accept cap screws from both directions.
- I. Operator: Lever handle with ten-position latching mechanism, except where noted below.
 1. Chainwheel Operators: Required for butterfly valves larger than NPS 4 (DN 100), if installed 96 inches (2400 mm) or higher above finished floor elevation.
 2. Gear Drive: Required for butterfly valves NPS 8 (DN 200) and larger, and for any butterfly valves larger than NPS 4 (DN 100) if installed 96 inches (2400 mm) or higher above finished floor elevation, to accommodate a chainwheel operator.

2.5 CHECK VALVES

- A. Bronze Swing Check Valve, NPS 2 (DN50) and smaller: Valve shall conform to MSS SP-80.
 1. Minimum pressure rating: Class 150.
 1. Body: ASTM B62 bronze body, y-pattern.
 2. Bonnet: ASTM B62 bronze, threaded, removable for regrinding.
 3. Disc and seat: Renewable; ASTM B62 bronze with bronze-alloy hinge pin.
 4. Hardware: Bronze.
 5. Ends: Threaded.
- B. Cast-Iron Swing Check Valves, NPS 2½ (DN65) and larger: Valve shall conform to MSS SP-71, Type I.
 1. Minimum pressure rating: Class 125.
 2. Body: ASTM A126 Cl. B cast-iron body and bronze-mounted (IBBM).
 3. Bonnet: ASTM A126 Cl. B cast-iron, bolted to body with steel bolts.
 4. Disc and seat: Renewable; Ductile-iron or bronze-alloy.
 5. Ends: Flanged.

- C. Wafer Check Valves, NPS 2½ (DN65) and larger: Valve shall conform to API 594.
 - 1. Minimum pressure rating: Class 125.
 - 2. Body: ASTM A126 Cl. B cast-iron.
 - 3. Discs: Dual-plate aluminum bronze, spring-loaded, butterfly style.
 - 4. Spring and hinge hardware: Type 316 stainless steel.
 - 5. Ends: Wafer style, with diameter made to fit within bolt circle of adjacent flanges.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- D. Examine threads on valve and mating pipe for form and cleanliness.
- E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves as indicated, according to manufacturer's written instructions.
- B. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- C. Install isolation valves at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- D. Locate valves for easy access and provide separate support where necessary. Install valves in horizontal piping with stem at or above center of pipe. Install valves in position to allow full stem movement.
- E. Any valve that represents a termination or the end of a run (e.g., blowdown or drain valve, hose-end valve, etc.) shall be fitted with a permanent but removable cap, plug, or blind flange matching the valve construction, to minimize risk in the event the valve is accidentally opened under pressure.
- F. Install chainwheel operators where specified. Extend chains to within 60 inches (1520 mm) above finished floor elevation.
- G. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level, or vertical with upward flow.

3.3 JOINT CONSTRUCTION

- A. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.
- B. Threaded Connections: Note the internal length of threads in valve ends and proximity of valve internal seat or wall to determine how far pipe should be threaded into valve.
 - 1. Align threads at point of assembly.
 - 2. Apply appropriate tape or thread compound to the external pipe threads, except where dry seal threading is specified.
 - 3. Assemble joint, wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.
- C. Flanged Connections: Align flange surfaces parallel.
 - 1. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.
 - 2. For dead-end service, butterfly valves require flanges both upstream and downstream for proper shutoff and retention.

3.4 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.5 VALVE APPLICATIONS SCHEDULE

- A. General: Refer to piping Sections and Drawings for specific valve applications. If no specific valve type is indicated, use the valve types indicated in the following schedules.
- B. HVAC Chilled Water, Condenser Water, Hydronic Heating Water Piping, HVAC Makeup Water and Drain Piping: Use the following types of valves. Choices are contractor's option unless a specific type of valve is specifically called out by name on the Drawings.
 - 1. For shutoff duty, NPS 2 (DN 50) and smaller, use ball valves.
 - 2. For shutoff duty, NPS 2½ (DN 65) and larger, use butterfly valves.
 - 3. For throttling duty, NPS 2 (DN 50) and smaller, use ball valves or globe valves.
 - 4. For throttling duty, NPS 2½ (DN 65) and larger, use butterfly valves or globe valves.
 - 5. For pump discharge protection, NPS 2 (DN 50) and smaller, use swing check valves.
 - 6. For pump discharge protection, NPS 2½ (DN 65) and larger, use wafer check valves.
 - 7. For one-way flow control other than at pump discharge, use swing check valves in all sizes.

END OF SECTION 23 0523

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SECTION 23 0529 – HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes hangers and supports for mechanical system piping and equipment, including but not limited to the following:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Pipe stands.
 - 7. Equipment stands.
 - 8. Equipment supports.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 23 0100 "Basic Mechanical Requirements," and Section 23 0500 "Basic Mechanical Materials and Methods" all apply to the work of this Section as if fully repeated herein.
- C. The following Sections contain requirements that relate to this Section:
 - 1. Division 05 Sections for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports; and for materials for attaching hangers and supports to building structure.
 - 2. Division 23 Section "Mechanical Vibration Isolation" for vibration isolation devices.
 - 3. Division 23 Section "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90 *Guidelines on Terminology for Pipe Hangers and Supports*.

1.4 PERFORMANCE REQUIREMENTS

- A. If contractor elects to apply channel support systems and/or heavy-duty steel trapezes to support multiple pipes, in lieu of individual supports, then contractor is responsible for design of same capable of supporting combined weight of supported systems, system contents, and test water. Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Do not suspend pipe hangers and supports from roof deck. Suspend such loads from structural steel only, and provide structural steel sub-framing as required.
- D. Do not suspend piping loads exceeding 500 pounds within any 100 square feet of contiguous area from supported concrete floor slabs. Suspend such loads from structural members only, and provide structural steel sub-framing as required.
- E. Structural Performance: Hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1.5 SUBMITTALS

- A. Product Data: For each type of pipe hanger, channel support system component, and thermal-hanger shield insert indicated. Include:
 - 1. Metal pipe hangers and supports.
 - 2. Thermal-hanger shield inserts.
 - 3. Fastener systems.
 - 4. Pipe stands.
- B. Shop Drawings: Shop drawings signed and sealed by a qualified professional engineer are required for the following custom pipe and equipment hangers and supports. Show fabrication and installation details and analysis data, and include calculations. Include Product Data for components.
 - 1. All equipment stands and supports for equipment weighing 500 lbs (227 kg) or more.

2. Trapeze pipe hangers supporting an individual pipe larger than 12-inch (DN 300), two pipes larger than 8-inch (DN 200), three or four pipes larger than 6-inch (DN150), or any trapeze supporting five or more pipes of any size.
3. Metal framing systems supporting an individual pipe larger than 12-inch (DN 300), two pipes larger than 8-inch (DN 200), three or four pipes larger than 6-inch (DN150), or any trapeze supporting five or more pipes of any size.
4. All custom pipe supports for steam systems operating above 15 psig (105 kPa).
5. All custom pipe supports for hydronic systems operating above 160 psig (105 kPa) or 250°F (121°C).

1.6 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M *Structural Welding Code – Steel*.
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications."
- C. ANSI/MSS Standard SP-58-2018 *Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation* including Amendment 1 Issued October 17, 2019, is hereby incorporated by reference. This Standard establishes:
 1. Minimum requirements for materials, allowable stresses, product design, testing, and load ratings for pipe hanger and support assemblies for standard and unique pipe hangers and supports.
 2. Inspection criteria for the manufacture and installation of pipe hangers and supports.
 3. Required procedures for packing, marking, shipping, receiving, and storage of pipe hangers and supports.
 4. Minimum requirements for pipe hanger and support assembly drawings.
 5. Field practices for installation, adjustment, testing, and inspection of pipe hangers and supports.
 6. Terminology and identification of pipe hangers and supports, along with recommended contractual relationship structures.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Manufactured Pipe Hangers:
 - a. Anvil International, Inc.
 - b. Cooper B-Line, Inc.
 - c. Carpenter & Patterson, Inc.
 - d. Erico International Corp.
 - e. PHD Manufacturing, Inc.
 - f. Tolco division of Cooper B-Line, Inc.
2. Metal Framing Systems:
 - a. Anvil International, Inc.
 - b. Cooper B-Line, Inc.
 - c. Erico / Michigan Hanger Co.
 - d. Thomas & Betts Corporation.
 - e. Tolco division of Cooper B-Line, Inc.
 - f. Unistrut Corporation; Tyco International, Ltd.
3. Thermal-Hanger Shield Inserts:
 - a. Carpenter & Paterson, Inc.
 - b. Erico International Corp.
 - c. PHS Industries, Inc.
 - d. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
4. Powder-Actuated Fastener Systems:

- a. Hilti, Inc.
- b. ITW Ramset/Red Head.
- c. Simpson Manufacturing Co.; Strong-Tie Anchor Systems Div.

5. Roof-Mounted Pipe Stands:

- a. "Caddy Pyramid" by Erico International Corp.
- b. Mapa Products.
- c. Miro Industries, Inc.

2.2 METAL PIPE HANGERS AND SUPPORTS

- A. Application: Refer to "Hanger and Support Applications" Article in Part 3 for where to use specific hanger and support types, including special padding or coatings where required.
- B. Carbon-Steel Pipe Hangers and Supports: MSS SP-58, Types 1 through 58, factory-fabricated components with pre-galvanized or hot dipped galvanized coatings. Include continuous-thread hanger rods, nuts, and washer made of carbon steel unless noted otherwise.
- C. Stainless-Steel Pipe Hangers and Supports: MSS SP-58, Types 1 through 58, factory-fabricated components. Include continuous-thread hanger rods, nuts, and washer made of stainless steel unless noted otherwise.
- D. Copper Pipe Hangers: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components. Include continuous-thread hanger rods, nuts, and washer made of stainless steel unless noted otherwise.
 - 1. Riser Clamp: Riser clamps for insulated copper piping installed in a vertical configuration shall be a pre-engineered support meeting ANSI/MSS SP-58 Type 8; with carbon steel clamp and a thermoplastic polyolefin insert to support the weight of the riser pipe with insulation. Design shall provide insulation crush-resistance, maintain vapor barrier for below-ambient pipe services, and protect insulation ends from compression and tears. Capacity shall be not less than 320 pounds [145 kg] of vertical load. Comply with 25/50 Flame Spread/Smoke Development Index according to UL 2043 *Fire Test for Heat and Visible Smoke Release*.
- E. Trapeze Pipe Hangers: Shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

- A. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes, according to Standard MFMA-4. Galvanized steel construction if located indoors; stainless steel construction if located outdoors.
- B. Channels: Continuous slotted steel channel with inturred lips.
- C. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
- D. Hanger Rods: As specified for Metal Pipe Hangers and Supports above.
- E. Coatings: Manufacturer's standard finish, unless otherwise noted.
 - 1. Metallic Coating: Hot-dipped galvanized.
 - 2. Paint Coating: Epoxy.

2.4 THERMAL-HANGER SHIELD INSERTS

- A. Insulation-Insert Material: ASTM C552, Type II cellular glass with 100-psig (688-kPa) or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength and vapor barrier.
- B. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- C. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- D. Insert Length: Extend 2-inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

- B. Mechanical-Expansion Anchors: Insert-wedge-type, stainless- steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
- C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
- D. High-Type, Single-Pipe Stand:
 - 1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 - 2. Base: Stainless steel.
 - 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
 - 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- E. High-Type, Multiple-Pipe Stand:
 - 1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 - 2. Bases: One or more; plastic.
 - 3. Vertical Members: Two or more protective-coated-steel channels.
 - 4. Horizontal Member: Protective-coated-steel channel.
 - 5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
- F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.7 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.
- B. Roof Curb-Type Equipment Rails: 18-gauge galvanized steel, unitized construction with integral base plate, continuous welded corner seams, pressure-treated wood nailer, counter-flashing with screws. Internally reinforced to conform with load bearing factors. Wood nailer shall include 1-inch overhang unless otherwise noted. Subject to compliance with requirements, example of acceptable product is The Pate Company's Model ES-5b.
- C. Outdoor Equipment Stands: Individual foot supports with elevated adjustable channel cross bars and clamps/fasteners/bolts for ground-supported or roof-supported outdoor equipment components, without roof membrane penetration, in a pre-fabricated system that can be modularly-assembled on site.
 - 1. Foot Material: Rubber or polypropylene.
 - 2. Rails Material and all Hardware: Stainless steel.
 - 3. Wind/Sliding Load Resistance: Up to 100 mph (44 m/s) minimum.
- D. Design all suspended equipment supports to resist forces of 0.5 times the equipment weight in any horizontal direction and 1.5 times the equipment weight in the downward direction. These requirements shall be increased to account for forces required by other criteria, such as seismic standards, as may be specified elsewhere.

2.8 MISCELLANEOUS MATERIALS

- A. Structural and Miscellaneous Steel: As specified in Division 23 Section "Basic Mechanical Materials and Methods."
- B. Grout: As specified in Division 23 Section "Basic Mechanical Materials and Methods."

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT SCHEDULE OF APPLICATIONS

- A. Comply with MSS SP-58 for pipe hanger and trapeze selections and applications that are not specified in this Section.
- B. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use copper-plated pipe hangers and copper or stainless-steel attachments, or use plastic coatings on attachments for electrolytic protection, where hangers are in direct contact with copper tubing.
- E. Use stainless-steel pipe hangers and supports, stainless-steel metal framing systems, and all stainless-steel hardware and attachments for hostile environment applications, including the following:
 - 1. All piping installed outdoors.
- F. Horizontal-Piping Hangers and Supports for the first three hangers/supports or the first 50-feet (whichever is greater) adjacent to Pumps: Use spring hangers and supports. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports shall include the following types:
 - 1. Horizontal (MSS Type 54): Mounted horizontally.
 - 2. Vertical (MSS Type 55): Mounted vertically.
 - 3. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
 - 4. Exception: Spring hangers are not required adjacent to inline pumps that are smaller than 5-horsepower. Use other types of hangers and supports as listed for service below.
- G. Horizontal-Piping Hangers and Supports for individual, insulated pipe runs which are both 2½-inch diameter or larger and 20 feet or longer: Unless otherwise indicated, choose among the following types:
 - 1. Single Pipe Rolls (MSS Type 41): For suspension of pipes from two rods.
 - 2. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes from single rod.
 - 3. Complete Pipe Rolls (MSS Type 44): Where vertical adjustment is not necessary.
 - 4. Adjustable Pipe Roll and Base Units (MSS Type 46): For vertical and lateral adjustment.
 - 5. For any of the above, include protection saddles and/or shields as applicable, and as further specified under the heading "Protection of Insulated Piping" elsewhere in this section.
 - 6. Exception: Piping whose normal operating temperature is less than 150°F (e.g., chilled water, condenser water) may be supported with static hangers specified in the next paragraph.
- H. Horizontal-Piping Hangers and Supports for individual pipe runs less than 20 feet long and all piping 2-inch diameter or smaller, regardless of length: Unless otherwise indicated, choose among the following types:
 - 1. Adjustable Steel Clevis Hangers (MSS Type 1).
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For pipes NPS 4 and larger.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3).
 - 4. Steel Pipe Clamps (MSS Type 4).
- I. Horizontal-Piping Hangers and Supports for individual uninsulated pipe runs of any size or length: Unless otherwise indicated, choose among the following types:
 - 1. Adjustable Steel Clevis Hangers (MSS Type 1).
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For pipes NPS 4 and larger.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3).
 - 4. Steel Pipe Clamps (MSS Type 4).
 - 5. Adjustable Steel Band Hangers (MSS Type 7): For pipes up to NPS 2 only.
 - 6. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For pipes up to NPS 2 only.
 - 7. U-Bolts (MSS Type 24).
- J. Vertical-Piping Hangers and Supports for individual, insulated pipe runs which are both 2½-inch diameter or larger and 20 feet or longer: Use spring hangers and supports. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports shall include the following types:
 - 1. Horizontal (MSS Type 54): Mounted horizontally.
 - 2. Vertical (MSS Type 55): Mounted vertically.
 - 3. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- K. Vertical-Piping Hangers and Supports for individual pipe runs less than 20 feet long and all piping 2-inch diameter or smaller, regardless of length: Unless otherwise indicated, choose among the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8). Use pre-engineered riser clamp with TPO insert for insulated copper piping as specified in Part 2 of this Section.
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): Where longer ends are required.
- L. Vertical-Piping Hangers and Supports for individual uninsulated pipe runs of any size or length: Unless otherwise indicated, choose among the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8).
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): Where longer ends are required.

- M. Hanger-Rod Attachments: Unless otherwise indicated, choose among the following types:
1. Steel Turnbuckles (MSS Type 13).
 2. Steel Clevises (MSS Type 14).
 3. Malleable-Iron Sockets (MSS Type 16).
 4. Steel Weldless Eye Nuts (MSS Type 17).
- N. Building Attachments: Unless otherwise indicated, choose among the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to concrete ceiling.
 2. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 3. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams.
 4. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 5. Light Welded-Steel Brackets (MSS Type 31): For support of pipes from below or for suspending from above up to 750 lb. by using clip and rod.
 6. Medium Welded-Steel Brackets (MSS Type 32): For support of pipes from below or for suspending from above up to 1500 lb. by using clip and rod.
 7. Heavy Welded-Steel Brackets (MSS Type 33): For support of pipes from below or for suspending from above up to 3000 lb. by using clip and rod.
 8. Side-Beam Brackets (MSS Type 34): For sides of steel beams.
 9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

3.2 HANGER AND SUPPORT MAXIMUM SPACING AND MINIMUM ROD SIZE

- A. Install hangers and supports with the following maximum spacing and minimum rod sizes.
- B. Flanged, Threaded, or Welded Steel Piping for any Liquid-service piping systems:
1. NPS ¾ (DN 20): Maximum span, 7 feet (2.1 m); minimum rod size, 3/8-inch (10 mm).
 2. NPS 1 (DN 25): Maximum span, 7 feet (2.1 m); minimum rod size, 3/8-inch (10 mm).
 3. NPS 1¼ (DN 32): Maximum span, 7 feet (2.1 m); minimum rod size, 3/8-inch (10 mm).
 4. NPS 1½ (DN 40): Maximum span, 9 feet (2.7 m); minimum rod size, 3/8-inch (10 mm).
 5. NPS 2 (DN 50): Maximum span, 10 feet (3 m); minimum rod size, 3/8-inch (10 mm).
 6. NPS 2½ (DN 65): Maximum span, 11 feet (3.4 m); minimum rod size, 1/2-inch (13 mm).
 7. NPS 3 (DN 80): Maximum span, 12 feet (3.7 m); minimum rod size, 1/2-inch (13 mm).
 8. NPS 4 (DN 100): Maximum span, 14 feet (4.3 m); minimum rod size, 5/8-inch (16 mm).
 9. NPS 5 (DN 125): Maximum span, 17 feet (5.2 m); minimum rod size, 3/4-inch (19 mm).
 10. NPS 6 (DN 150): Maximum span, 17 feet (5.2 m); minimum rod size, 3/4-inch (19 mm).
 11. NPS 8 (DN 200): Maximum span, 19 feet (5.8 m); minimum rod size, 7/8-inch (22 mm).
 12. NPS 10 (DN 250): Maximum span, 20 feet (6.1 m); minimum rod size, 7/8-inch (22 mm).
- C. Flanged, Threaded, or Welded Steel Piping for Steam piping systems:
1. NPS ¾ (DN 20): Maximum span, 9 feet (2.7 m); minimum rod size, 3/8-inch (10 mm).
 2. NPS 1 (DN 25): Maximum span, 9 feet (2.7 m); minimum rod size, 3/8-inch (10 mm).
 3. NPS 1¼ (DN 32): Maximum span, 9 feet (2.7 m); minimum rod size, 3/8-inch (10 mm).
 4. NPS 1½ (DN 40): Maximum span, 12 feet (3.7 m); minimum rod size, 3/8-inch (10 mm).
 5. NPS 2 (DN 50): Maximum span, 13 feet (4 m); minimum rod size, 3/8-inch (10 mm).
 6. NPS 2½ (DN 65): Maximum span, 14 feet (4.3 m); minimum rod size, 1/2-inch (13 mm).
 7. NPS 3 (DN 80): Maximum span, 15 feet (4.6 m); minimum rod size, 1/2-inch (13 mm).
 8. NPS 4 (DN 100): Maximum span, 17 feet (5.2 m); minimum rod size, 5/8-inch (16 mm).
 9. NPS 5 (DN 125): Maximum span, 20 feet (6.1 m); minimum rod size, 3/4-inch (19 mm).
 10. NPS 6 (DN 150): Maximum span, 20 feet (6.1 m); minimum rod size, 3/4-inch (19 mm).
 11. NPS 8 (DN 200): Maximum span, 20 feet (6.1 m); minimum rod size, 7/8-inch (22 mm).
 12. NPS 10 (DN 250): Maximum span, 20 feet (6.1 m); minimum rod size, 7/8-inch (22 mm).
- D. Drawn-Temper Copper Piping for any liquid-service piping systems:
1. NPS ¾ (DN 20): Maximum span, 5 feet (1.5 m); minimum rod size, 3/8-inch (10 mm).
 2. NPS 1 (DN 25): Maximum span, 6 feet (1.8 m); minimum rod size, 3/8-inch (10 mm).
 3. NPS 1¼ (DN 32): Maximum span, 6 feet (1.8 m); minimum rod size, 3/8-inch (10 mm).
 4. NPS 1½ (DN 40): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8-inch (10 mm).
 5. NPS 2 (DN 50): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8-inch (10 mm).
- E. Polypropylene, CPVC and PVC Piping for any service:
1. NPS ¾ (DN 20): Maximum span, 3 feet (0.9 m); minimum rod size, 3/8-inch (10 mm).
 2. NPS 1 (DN 25): Maximum span, 3 feet (0.9 m); minimum rod size, 3/8-inch (10 mm).
 3. NPS 1¼ (DN 32): Maximum span, 4 feet (1.2 m); minimum rod size, 3/8-inch (10 mm).
 4. NPS 1½ (DN 40): Maximum span, 4 feet (1.2 m); minimum rod size, 3/8-inch (10 mm).

5. NPS 2 (DN 50): Maximum span, 4 feet (1.2 m); minimum rod size, 3/8-inch (10 mm).
 6. NPS 2½ (DN 65): Maximum span, 4 feet (1.2 m); minimum rod size, 1/2-inch (13 mm).
- F. Cast Iron and/or Ductile Iron Piping: Install hangers at the same maximum spacing and with the same minimum rod sizes as for Steel Piping for hydronic system service, except that maximum spacing shall not exceed 12 feet and smallest rod size allowed is ½-inch.
1. Vertical piping: Shall be supported at each stack base and at each floor. Free standing vertical pipe should be adequately staked or braced during construction to maintain alignment.
 2. Horizontal piping: Shall be supported within 18-inches of the coupling joint at maximum 10 foot intervals for 10 foot pipe lengths and at maximum 5 foot intervals for 5 foot pipe lengths. Support or hangers should be properly placed to maintain alignment and grade with provision made to prevent shear. Large diameter pipe should be braced at changes of direction to prevent horizontal movement.
- G. Support vertical runs at roof, at each floor, and at 10-foot (3-m) intervals between floors.
- H. Rod diameters may be reduced one size for double-rod hangers, with 3/8-inch (10 mm) minimum rods.
- I. Hanger and support spacing for piping and tubing not listed above shall be according to MSS SP-58 and piping manufacturer's written instructions.

3.3 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-58 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Field fabricate from ASTM A36/A36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M. Comply with MSS SP-58 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers. Support pipes of various sizes together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Required for insulated piping NPS 4 and larger if piping operates below surrounding ambient air temperature.
- E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- F. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- G. Install lateral bracing with pipe hangers and supports to prevent swaying.
- H. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- I. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2½ (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- K. Repair any building insulation or building fireproofing materials, whether new or existing, that are removed or scraped away in order to attach hangers and supports, so as to maintain an equivalent insulation or fire rating as existed without said hanger or support attachment.
- L. Fastener System Installation:
1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4-inches (100 mm) thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

- M. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Division 07 Section "Roof Accessories" for curbs.
- N. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

3.4 PROTECTION OF INSULATED PIPING:

- A. Attach clamps and spacers to piping.
 - 1. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - 2. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
- B. Do not exceed pipe stress limits according to ASME B31.9.
- C. Piping Operating above Ambient Air Temperature: Clevis- and clamp-type supports shall project through insulation, with pipe support making direct contact with pipe and with insulation applied in a manner that encapsulates the clevis or clamp. For piping on roller-type supports, install MSS SP-58, Type 39 protection saddles, and fill interior voids with insulation that matches adjoining insulation.
 - 1. Contractor's Option: In lieu of the above paragraph, contractor has the option of complying with the same specifications as for "Piping Operating below Ambient Air Temperature" in the following paragraphs.
- D. Piping Operating below Ambient Air Temperature: Clevis- and clamp-type supports shall be sized for the outside diameter of the insulation including jacket. Install MSS SP-58, Type 40 protective metal shields. Shields shall span an arc of 180 degrees.
 - 1. Pipe Sizes NPS 4 (DN 100) and larger: Include thermal-hanger shield inserts. Insert shall be same thickness as adjoining pipe insulation and length shall be at least as long as the protective shield. Include steel weight-distribution plate if pipe is installed on rollers.
 - 2. Metal Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 3½ (DN 90) and smaller: 12-inches (300 mm) long and 0.048-inch (1.22 mm) thick.
 - b. NPS 4 (DN 100): 12-inches (300 mm) long and 0.06-inch (1.52 mm) thick.
 - c. NPS 5 and NPS 6 (DN 125 & 150): 18-inches (450 mm) long and 0.06-inch (1.52 mm) thick.
 - d. NPS 8 to NPS 14 (DN 200 to DN 350): 24-inches (610 mm) long and 0.075-inch (1.91 mm) thick.
 - 3. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
 - 4. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.5 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor. Provide lateral bracing, to prevent swaying, for equipment supports.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

3.6 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and/or equipment supports. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- B. Field Welding: Comply with AWS D1.1 procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals. Obtain fusion without undercut or overlap. Remove welding flux immediately. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.7 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe. Trim excess length of continuous-thread hanger and support rods to 1½-inches (40 mm).

3.8 PAINTING

- A. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

END OF SECTION 23 0529

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SECTION 23 0540 – MECHANICAL VIBRATION ISOLATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes vibration isolation pads, mounts, hangers, and vibration isolation bases for mechanical and HVAC services.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 23 0100 “Basic Mechanical Requirements,” and Section 23 0500 “Basic Mechanical Materials and Methods” all apply to the work of this Section as if fully repeated herein.
- C. The following Sections contain requirements that relate to this Section:
 - 1. Division 23 Section “Basic Mechanical Materials and Methods” for flexible pipe connectors.
 - 2. Division 23 Section “Hangers and Supports” for pipe hanger restraints.
 - 3. Division 23 Section “Metal Ducts” for flexible duct connectors.

1.3 SUBMITTALS

- A. Product Data: types, styles, materials, and finishes for each type of isolator specified. Include load deflection curves for each vibration isolation device.

1.4 QUALITY ASSURANCE

- A. Single-Source: All vibration isolation devices shall be the product of a single manufacturer.

1.5 COORDINATION

- A. Coordinate layout and installation of vibration isolation devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Sections.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
 - 1. California Dynamics Corp.
 - 2. Kinetics Noise Control, Inc.
 - 3. Mason Industries, Inc.
 - 4. Tolco division of Eaton/Cooper.
 - 5. Vibration Eliminator Co., Inc.
 - 6. Vibro-Acoustics, Inc.
 - 7. The VMC Group; Amber/Booth, Korfund, and VMC brands.
- B. Model numbers by Mason Industries, Inc. are listed below to establish the level of quality required; equal products by other listed manufacturers are acceptable under the “Material and Equipment Selection” terms of Division 23 Section “Basic Mechanical Requirements.”
- C. All neoprene referred to hereinafter shall be oil resistant, compounded for not greater than 65 durometer, minimum tensile strength of 2000 psi, minimum elongation of 300%, and maximum compression set at 25% of the original deflection.
- D. Where exposed to the atmosphere, all steel shall be hot dipped galvanized unless noted otherwise.
- E. All hardware shall be cadmium plated, and all springs shall be neoprene coated.

2.2 VIBRATION ISOLATORS

- A. Elastomeric Isolator Pads (Schedule Designation Type 1): Oil and water resistant and factory cut to sizes that match requirements of the equipment supported. Load range from 10 to 50 psig (69 to 345 kPa) and a deflection not less than 0.08-inch per 1-inch (2 mm per 25 mm) of thickness. Do not exceed a loading of

- 50 psig (345 kPa). Neoprene arranged in single or multiple layers, molded with a non-slip ribbed or waffled pattern, and steel baseplates of sufficient stiffness to provide uniform loading over the pad area. Provide 5/16-inch minimum thickness. Provide 1/16-inch galvanized steel plate between multiple layers. Model MBSW by Mason Industries, Inc.
- B. Elastomeric Mounts (Schedule Designation Type 2): Double-deflection type, with molded, neoprene isolator elements, with encapsulated top- and baseplates. Factory-drilled and tapped top plate for bolted equipment mounting. Factory-drilled baseplate for bolted connection to structure. Color-code to indicate capacity range. Model ND by Mason Industries, Inc.
- C. Restrained Elastomeric Mounts (Schedule Designation Type 2R): All-directional elastomeric mountings with seismic restraint. Model RBA/RCA by Mason Industries, Inc.
1. Materials: Cast-ductile-iron housing containing two separate and opposing, molded, bridge-bearing neoprene elements that prevent central threaded sleeve and attachment bolt from contacting the casting during normal operation.
 2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.
- D. Spring Isolators (Schedule Designation Type 3): Freestanding, laterally stable, open-spring-type isolators. Design and install such that ends of springs remain parallel. Model SLF by Mason Industries, Inc.
1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 3. Lateral Stiffness: More than 1.2 times the rated vertical stiffness.
 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 5. Baseplates: Factory drilled for bolting to structure and bonded to ½-inch- (13-mm-) thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 100 psig (690 kPa).
 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- E. Restrained Spring Isolators (Schedule Designation Type 4): Same as Spring Isolators specified above, plus the following: Welded steel housing with resilient vertical limit stops to prevent spring extension due to wind loads or when weight is removed. Provide adjustable equipment mounting and leveling bolt. Unit shall be capable of supporting equipment at a fixed elevation during equipment erection. Model SLR by Mason Industries, Inc.
- F. Elastomeric Hangers (Schedule Designation Type 2H): Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range. Model HD by Mason Industries, Inc.
- G. Spring Hangers (Schedule Designation Type 3H): Combination coil-spring and elastomeric-insert hanger with spring and insert in compression. Model 30N by Mason Industries, Inc.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
- H. Spring Hangers with Vertical-Limit Stop (Schedule Designation Type 3HR): Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop. Model PC30N by Mason Industries, Inc.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
- I. Thrust Limits (Schedule Designation Type 5): Combination coil spring and elastomeric insert with spring and insert in compression and with a load stop. Include rod and angle-iron brackets for attaching to equipment. Factory set for thrust. Model WBI/WBD by Mason Industries, Inc.
1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 7. Coil Spring: Factory set and field adjustable for a maximum of ¼-inch movement at start and stop.
- J. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of ½-inch thick, 60-durometer neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.
- K. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes separated by a minimum of ½-inch thick, 60-durometer neoprene. Factory set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.3 VIBRATION ISOLATION EQUIPMENT BASES

- A. Steel Base (Schedule Designation Type B): Factory-fabricated, welded, structural-steel bases and rails. Model WFSL by Mason Industries, Inc.
1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails. Include supports for suction and discharge elbows for pumps. Include equipment static loadings, power transmission, component misalignment, and cantilever loadings.
 2. Structural Steel: Fabricate bases to shapes required, with welded structural-steel shapes, plates, and bars conforming to ASTM A 36 (ASTM A 36M). Include support brackets to anchor base to isolation units. Include prelocated equipment anchor bolts and auxiliary motor slide bases or rails. Bases shall have shape to accommodate supported equipment.
 3. Support Brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

2.4 FACTORY FINISHES

- A. Manufacturer's standard prime-coat finish ready for finish painting.
- B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
1. Powder coating on springs and housings.
 2. All hardware shall be electrogalvanized. Hot-dip galvanize metal components for exterior use.
 3. Baked enamel for metal components on isolators for interior use.
 4. Color-code or otherwise mark vibration isolation devices to indicate capacity range.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Examine areas and equipment to receive vibration isolation devices for compliance with requirements, installation tolerances, and other conditions affecting performance. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Install vibration control products in accordance with manufacturer's written instructions. Positive attachment of vibration control products to the isolated equipment is required. Positive attachment of vibration control products to the structure or floor is required. Do not rely on friction or gravity as a means of attachment.

- C. Install roof curbs, equipment supports, and roof penetrations as specified in Division 07 Section "Roof Accessories."
- D. Install thrust limits at centerline of thrust, symmetrical on either side of equipment.
- E. Install resilient bolt isolation washers on equipment anchor bolts.

3.2 ADJUSTING

- A. Adjust isolators after piping systems have been filled and equipment is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch (6-mm) movement during start and stop.
- D. Adjust active height of spring isolators.
- E. Adjust snubbers according to manufacturer's written recommendations.
- F. Torque anchor bolts according to equipment manufacturer's written recommendations to resist seismic forces.

3.3 CLEANING

- A. After completing equipment installation, inspect vibration isolation and seismic-control devices. Remove paint splatters and other spots, dirt, and debris.

3.4 VIBRATION ISOLATOR SCHEDULE

- A. Select and provide specific types of Vibration Isolators as scheduled below; if not scheduled, then as listed in Table 47, Chapter 49 of the *2019 ASHRAE Handbook of HVAC Applications*.
- B. All of the Vibration Isolators Scheduled are field-supplied and field-installed external to the respective equipment unit. See each individual Division 23 specification section for additional factory-installed Vibration Isolators internal to each respective equipment unit.

END OF SECTION 23 0540

SECTION 23 0700 - MECHANICAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes mechanical insulation for ductwork, equipment, piping, and other installations, including the following:
 - 1. Insulation Material:
 - a. Flexible elastomeric.
 - b. Mineral fiber.
 - 2. Fire-rated insulation systems.
 - 3. Insulating cements, adhesives, mastics, and sealants.
 - 4. Factory-applied jackets.
 - 5. Field-applied jackets.
 - 6. Tapes and securements.
 - 7. Corner angles.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 23 0100 "Basic Mechanical Requirements," and Section 23 0500 "Basic Mechanical Materials and Methods" all apply to the work of this Section as if fully repeated herein.
- C. The following Sections contain requirements that relate to this Section:
 - 1. Division 23 Section "Metal Ducts" for internal duct liners.

1.3 DEFINITIONS

- A. ASJ: All-service jacket.
- B. FSK: Foil, scrim, kraft paper.
- C. SSL: Self-sealing lap.
- D. Thermal Resistivity: "R-values" represent the reciprocal of thermal conductivity (k-value). Thermal conductivity is the rate of heat flow through a homogenous material exactly 1-inch thick. Thermal resistivities are expressed by the temperature difference in degrees F between two exposed faces required to cause one BTU to flow through one square foot of material, in one hour, at a given mean temperature.
- E. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.
- F. Exposed Installations: Exposed to view. Examples include finished occupied spaces without ceilings, mechanical equipment rooms, courtyards and rooftop locations.
- G. Concealed Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings or within duct shafts.
- H. Conditioned Space: Spaces that are served by both a mechanical heating and mechanical cooling system are conditioned spaces. Heating-only spaces are not conditioned spaces. The space above a ceiling is considered conditioned space if the space directly below that ceiling is conditioned space. A vertical shaft is considered conditioned space if the spaces on all sides surrounding the shaft are conditioned spaces.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated, identify thermal conductivity, thickness, and jackets (both factory and field applied, if any).
- B. MSDS (Material Safety Data Sheet) for each adhesive, mastic, sealant, and cement furnished.
- C. Shop Drawings: Show details for the following:
 - 1. Application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Attachment and covering of heat tracing inside insulation.
 - 3. Insulation application at pipe expansion joints for each type of insulation.
 - 4. Insulation application at elbows, fittings, flanges, valves, couplings, and specialties for each type of insulation.
 - 5. Removable insulation at piping specialties, equipment connections, and access panels.
 - 6. Application of field-applied jackets.

7. Application at linkages of control devices.
8. Field application for each equipment type.

D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:

1. Preformed Pipe Insulation Materials: 12-inches (300 mm) long by NPS 2 (DN 50).
2. Sheet Form Insulation Materials: 12-inches (300 mm) square.
3. Jacket Materials for Pipe: 12-inches (300 mm) long by NPS 2 (DN 50).
4. Sheet Jacket Materials: 12-inches (300 mm) square.
5. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: Insulation and related materials shall have flame-spread index of 25 or less, and smoke-developed index of 50 or less, as determined by testing identical products per ASTM E84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports."
- B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
 1. Flexible Elastomeric Insulation:
 - a. Aeroflex USA Inc.; Aerocel.
 - b. Armacell LLC; AP/Armaflex.
 - c. K-Flex USA; Insul-Lock® Seam-Seal.
 - d. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.
 2. Mineral Fiber Insulation:
 - a. CertainTeed Corp.
 - b. Johns Manville.
 - c. Knauf Insulation.
 - d. Manson Insulation Inc.
 - e. Owens Corning.
 3. Fire-Rated Insulation Systems:
 - a. 3M
 - b. CertainTeed Corporation

- c. Johns Manville; a Berkshire Hathaway Company
 - d. Nelson Firestop; a brand of Emerson Industrial Automation
 - e. Thermal Ceramics
 - f. Unifrax Corporation
- 4. Insulating Cements: Same as insulation manufacturer, or
 - a. Insulco, Division of MFS, Inc.
 - b. P. K. Insulation Mfg. Co., Inc.
 - c. Rock Wool Manufacturing Company.
- 5. Sealants, Adhesives and Mastics: Same as insulation manufacturer, or
 - a. H.B. Fuller Construction Products Inc. (Childers and/or Foster brands)
 - b. ITW TACC, Division of Illinois Tool Works.
 - c. Marathon Industries, Inc.
 - d. Mon-Eco Industries, Inc.
 - e. Vimasco Corporation.
- 6. Field-Applied Jackets: Same as insulation manufacturer, or
 - a. P.I.C. Plastics, Inc.
 - b. PABCO Metals Corporation.
 - c. Pittsburgh Corning Corporation.
 - d. Polyguard Products, Inc.
 - e. Proto PVC Corporation.
 - f. RPR Products, Inc.
 - g. Speedline Corporation.
- 7. Tapes: Same as insulation manufacturer, or
 - a. Avery Dennison Corporation, Specialty Tapes Division.
 - b. Compac Corp.
 - c. Ideal Tape Co., Inc., an American Biltrite Company.
 - d. Polyguard Products, Inc.
 - e. Venture Tape.
- 8. Bands and Wire: Same as insulation manufacturer, or
 - a. ACS Industries, Inc.
 - b. C & F Wire.
 - c. Childers Products.
 - d. PABCO Metals Corporation.
 - e. RPR Products, Inc.
- 9. Insulation Pins and Hangers: Same as insulation manufacturer, or
 - a. AGM Industries, Inc.
 - b. GEMCO.
 - c. Midwest Fasteners, Inc.
 - d. Nelson Stud Welding.

2.2 INSULATION MATERIALS

- A. Refer to Schedule in Part 4 for requirements about where insulating materials shall be applied.
- B. Restrictions: Products shall not contain asbestos, lead, mercury, or mercury compounds. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.
- D. Adhesives shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- E. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534, Type I for tubular materials and Type II for sheet materials.
 - 1. Thermal Conductivity: 0.28 average maximum at 75°F mean temperature using test method ASTM C177 or C518.
 - 2. Water Vapor Permeability: Maximum 0.1 perm-inch using test method ASTM E96 Procedure A.

3. Water Absorption: Maximum 0.2% by volume using test method ASTM C209.
 4. Product shall pass mold growth, fungi resistance, and bacterial resistance tests per UL 181, ASTM G21, G22, and C1338.
 5. Adhesive: Comply with MIL-A-24179A, Type II, Class I; VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type II and ASTM C1290, Type III with factory-applied jacket.
1. Thermal Conductivity: 0.26 average maximum at 75°F mean temperature.
 2. Density: 1.5 lb/cf (24-kg/cu. m) minimum.
 3. Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
- G. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type IA or Type IB.
1. Thermal Conductivity: 0.26 average maximum at 75°F mean temperature.
 2. Density: 2.0 lb/cf (32-kg/cu. m) minimum.
 3. Jacket (Ducts): Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
 4. Jacket (Equipment): White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
- H. Mineral-Fiber, Preformed Pipe Insulation: Type I, 850°F (454°C); mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547, Type I, Grade A, with factory-applied jacket.
1. Thermal Conductivity: 0.26 average maximum at 75°F mean temperature.
 2. Jacket: White, polypropylene-coated kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I; with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip. Example of acceptable product is Owens-Corning ASJ Max-SSL or Johns Manville Micro-Loc HP Ultra.
 3. Adhesive: Water-based and complying with ASTM C916 Type II; equal to Foster 85-60 and/or Childers CP-127.
- I. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semi-rigid board material complying with ASTM C1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C612, Type IB.
1. Thermal Conductivity: 0.29 average maximum at 100°F mean temperature.
 2. Density: 2.5 lb/cf (40-kg/cu. m) minimum.
 3. Jacket: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I
 4. Adhesive: Water-based and complying with ASTM C916 Type II.
- J. FIRE-RATED INSULATION SYSTEMS
1. Fire-rated insulation is sometimes used in lieu of fire-rated assemblies for kitchen hood exhaust ductwork. Delete this whole section if not need on your Project. – SWD.
 2. Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700°F (927 C). Comply with ASTM C656, Type II, Grade 6 or with ASTM E2336. UL tested and certified to provide a 2-hour fire rating.
 3. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is UL tested and certified to provide a 2-hour fire rating.
 4. Lagging Adhesives: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
 - a. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
 - b. Service Temperature Range: -50 to +180°F (-46 to +82°C).
 - c. Color: White.

2.3 CEMENTS AND MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates. Comply with ASTM C755-19 *Standard Practice for Selection of Water Vapor Retarders for Thermal Insulation* Table 2, for the selection of vapor retarder systems.

- B. Insulating Cements: Select one or more of the following at contractor's option.
1. Mineral-Fiber Insulating Cement: Comply with ASTM C195.
 2. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.
 3. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.
- C. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below-ambient services, for applications on seams, punctures, penetrations, and terminations of vapor retarder membranes. Equal to Foster 30-80 or Childers CP-35 or Vimasco 749.
1. Water-Vapor Permeance, Piping and Equipment: ASTM E96-16, Procedure A (desiccant method), 0.15 perms.
 2. Water-Vapor Permeance, HVAC Ducts: ASTM E96-16, Procedure A (desiccant method), 1.0 perms.
 3. Service Temperature Range: -20 to +180°F (-29 to +82°C).
 4. Solids Content: ASTM D1644, 59 percent by volume and 71 percent by weight.
 5. Color: White.
- D. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services. Equal to Foster 46-50 or Childers CP-10/11 or Vimasco WC-5.
1. Water-Vapor Permeance: ASTM F1249, 3 perms (2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
 2. Service Temperature Range: -20 to +200°F (-29 to +93°C).
 3. Solids Content: 63 percent by volume and 73 percent by weight.
 4. Color: White.

2.4 SEALANTS

- A. Joint Sealants: Permanently flexible, elastomeric sealant. Materials shall be compatible with insulation materials, jackets, and substrates.
1. Service Temperature Range: -100 to +200°F (-73 to +94°C).
 2. Color: White, tan, or gray.
 3. VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. FSK and Metal Jacket Flashing Sealants: Fire- and water-resistant, flexible, elastomeric sealant. Materials shall be compatible with insulation materials, jackets, and substrates.
1. Service Temperature Range: -40 to +250°F (-40 to +121°C).
 2. Color: Aluminum.
 3. VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants: Fire- and water-resistant, flexible, elastomeric sealant. Materials shall be compatible with insulation materials, jackets, and substrates.
1. Service Temperature Range: -40 to +250°F (-40 to +121°C).
 2. Color: White.
 3. VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness 30 mils (0.8 mm); roll stock ready for shop or field cutting and forming.
1. Adhesive: Compatible with PVC, as recommended by jacket material manufacturer.
 2. Color: Finish color shall be selected by Architect and Engineer during shop drawing review process and shall be selected from manufacturer's standard color chart which shall offer at a minimum eight (8) standard colors to include primary colors and white, beige, brown and black.
 3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 4. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
 5. Factory-fabricated tank heads and tank side panels.
- C. Metal Jackets: Sheet and roll stock ready for shop or field sizing. Factory pre-cut and rolled to size is also acceptable.
1. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105 or 5005, Temper H-14. Finishes and thickness as follows:

- a. Indoor Ducts and Plenums: Smooth, 0.016-inch (0.41 mm) thick.
 - b. Indoor Equipment: Stucco Embossed, 0.016-inch (0.41 mm) thick.
 - c. Outdoor Ducts, Equipment, and Piping: Stucco embossed, with Z-shaped locking seam, 0.024-inch (0.61 mm) thick.
2. Stainless-Steel Jacket: ASTM A167 or ASTM A240; Type 304 stucco embossed, with Z-shaped locking seam; 0.016-inch (0.41 mm) thick.
 3. Moisture Barrier for Indoor Applications: 1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper.
 4. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.
 5. Factory-Fabricated Fitting Covers: Same material, finish, and thickness as jacket; provide as required for preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows, tee covers, flange and union covers, end caps, beveled collars, and valve covers.
 6. Field-fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.6 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136 and UL listed.
 1. Width: 3-inches (75 mm).
 2. Thickness: 11.5 mils (0.29 mm).
 3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136 and UL listed.
 1. Width: 3-inches (75 mm).
 2. Thickness: 6.5 mils (0.16 mm).
 3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
 6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: Vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
 1. Width: 2-inches (50 mm).
 2. Thickness: 6 mils (0.15 mm).
 3. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
 4. Elongation: 500 percent.
 5. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.
 6. Color: Color shall match PVC jacket.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive and UL listed.
 1. Width: 2-inches (50 mm).
 2. Thickness: 3.7 mils (0.093 mm).
 3. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
 4. Elongation: 5 percent.
 5. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

2.7 SECUREMENTS

- A. Bands:
 1. Stainless Steel: ASTM A167 or ASTM A240, Type 304; 0.015-inch (0.38 mm) thick, ½-inch (13 mm) wide with wing or closed seal.
 2. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020-inch (0.51 mm) thick, ½-inch (13 mm) wide with wing or closed seal.
 3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
 2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated with integral 1½-inch (38-mm) galvanized carbon-steel washer.
 3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Baseplate shall be perforated, galvanized carbon-steel sheet, 0.030-inch (0.76 mm) thick by 2-inches (50 mm) square. Spindle shall be copper, aluminum, or stainless steel, fully annealed, 0.106-inch (2.6-mm) diameter shank, length to suit depth of insulation indicated. Adhesive shall be as recommended by hanger manufacturer; with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
 4. Self-Sticking-Base Insulation Hangers: Adhesive-backed base with a peel-off protective cover; and baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Baseplate shall be galvanized carbon-steel sheet, 0.030-inch (0.76 mm) thick by 2-inches (50 mm) square. Spindle shall be copper, aluminum, or stainless steel, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
 5. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch (0.41-mm) thick, aluminum or stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1½-inches (38 mm) in diameter. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
- C. Staples: Outward-clinching insulation staples, nominal ¾-inch- (19-mm-) wide, stainless steel or Monel.
- D. Wire: 0.062-inch (1.6-mm) soft-annealed, stainless steel.

2.8 CORNER ANGLES

- A. PVC Corner Angles: 30 mils (0.8 mm) thick, minimum 1 by 1-inch (25 by 25 mm), PVC according to ASTM D1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040-inch (1.0 mm) thick, minimum 1 by 1-inch (25 by 25 mm), aluminum according to ASTM B209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.
- C. Stainless-Steel Corner Angles: 0.024-inch (0.61 mm) thick, minimum 1 by 1-inch (25 by 25 mm), stainless steel according to ASTM A167 or ASTM A240, Type 304 or 316.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application. Verify that systems and equipment to be insulated have been tested and are free of defects. Verify that surfaces to be insulated are clean and dry. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.
- C. All piping and ductwork insulation exposed spaces shall have field applied jacketing and/or field painted. Base bid shall be field applied jacketing. Wear insulation is painted, insulation shall have a paint grip finish. Prior to painting, clean and dry all surfaces to receive paint.

3.3 COMMON INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

- D. Install insulation with longitudinal seams at top and bottom of horizontal runs. Install multiple layers of insulation with longitudinal and end seams staggered.
- E. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer. Install insulation with least number of joints practical.
- H. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- I. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- J. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4-inches (100 mm) o.c.
 - 3. Overlap jacket longitudinal seams at least 1½-inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2-inches (50 mm) o.c.
 - 4. For below ambient services, apply vapor-barrier mastic over staples.
 - 5. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 - 6. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
- K. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- L. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- M. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4-inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- N. At the following locations, omit jacket and provide a separate cutaway removable segment of insulation clearly labeled "Access." For below-ambient services, provide a design that allows access but maintains vapor barrier.
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2-inches (50 mm) below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2-inches (50 mm).
 4. Seal jacket to wall flashing with flashing sealant.
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- D. Insulation Installation at Fire-Rated Wall and Partition Penetrations:
1. Install pipe insulation continuously through pipe penetrations of fire-rated walls and partitions.
 2. Install duct insulation continuously through duct penetrations of fire-rated walls and partitions, for cases where no fire or smoke damper is required.
 3. Terminate duct insulation at fire or smoke damper sleeves for cases where fire or smoke dampers are used, but overlap duct insulation at least 2-inches (50 mm) onto sleeve.
 4. Firestopping and fire-resistive joint sealers are specified in Division 07 Section "Penetration Firestopping."
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations:
1. Install pipe insulation continuously through pipe penetrations of fire-rated walls and partitions.
 2. Install duct insulation continuously through duct penetrations of fire-rated walls and partitions, for cases where no fire or smoke damper is required.
 3. Terminate duct insulation at fire or smoke damper sleeves for cases where fire or smoke dampers are used, but overlap duct insulation at least 2-inches (50 mm) onto sleeve.
 4. Firestopping and fire-resistive joint sealers are specified in Division 07 Section "Penetration Firestopping."
- F. Insulation Installation at Floor Penetrations:
1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2-inches (50 mm).
 2. Pipe: For below-ambient piping services, install insulation continuously through floor penetrations. For above-ambient piping services, either do the same as for below-ambient piping, or it is acceptable to install uninsulated piping through the slab and butt the pipe insulation tight to the slab on both the top side and the underneath side.
 3. Seal penetrations through fire-rated assemblies according to Division 07 Section "Penetration Firestopping."

3.5 DUCT INSULATION INSTALLATION

- A. See Part 4 Insulation Schedules for specific requirements.
- B. The following ductwork items need not be insulated, unless noted otherwise:
1. Fibrous-glass ducts.
 2. Metal ducts with internal duct liner.
 3. Factory-insulated flexible ducts.
 4. Factory-insulated plenums, casings, fan housings, and air terminal units.
 5. Flexible connectors.
 6. Vibration-control devices.
 7. Factory-insulated access panels and doors.
- C. Secure all insulation on ducts and plenums with insulation pins. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
1. On duct sides with dimensions 18-inches (450 mm) and smaller, pins may be omitted.
 2. On duct sides with dimensions 18-inches (450 mm) and larger, place pins along longitudinal centerline of duct. Space 3-inches (75 mm) maximum from insulation end joints, and 16-inches (400 mm) o.c.

3. On duct sides with dimensions larger than 36-inches (900 mm), place pins 16-inches (400 mm) o.c. each way, and 3-inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 4. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 5. Do not over-compress insulation during installation.
 6. If using blanket insulation, impale insulation over pins and attach speed washers.
 7. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
- D. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2-inches (50 mm) from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with ½-inch (13-mm) outward-clinching staples, 1-inch (25 mm) o.c. Complete the vapor barrier by applying FSK tape specified in Part 2, or vapor-barrier mastic and sealant, at all joints, seams, and protrusions.
1. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 2. Install vapor stops for ductwork and plenums operating below 50°F (10 C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3-inches (75 mm).
- E. If using blanket insulation, overlap unfaced blankets a minimum of 2-inches (50 mm) on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18-inches (450 mm) o.c.
- F. Unless factory-insulated, install duct insulation continuously and unbroken over duct-mounted accessories such as fans, coils, terminal units, humidifier housings, damper housings, airflow measuring station housings, etc.
- G. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. If using board insulation, groove and score insulation to fit as closely as possible to outside and inside radius of elbows.
- H. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
- I. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6-inches (150 mm) o.c.

3.6 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

- A. See Part 4 Insulation Schedules for specific requirements.
- B. Where required, secure blanket or board insulation to equipment, tanks and vessels with adhesive and anchor pins and speed washers.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of tank and vessel surfaces.
 2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
 3. Protect exposed corners with secured corner angles.
 4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels. Do not weld anchor pins to ASME-labeled pressure vessels. Select insulation hangers and adhesive that are compatible with service temperature and with substrate. On tanks and vessels, maximum anchor-pin spacing is 3-inches (75 mm) from insulation end joints, and 16-inches (400 mm) o.c. in both directions. Do not over-compress insulation during installation. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels. Impale insulation over anchor pins and attach speed washers. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
 6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch pre-stressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6-inches (150 mm) from each end. Install wire or cable between two circumferential girdles 12-inches (300 mm) o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch pre-stressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install

- additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48-inches (1200 mm) o.c. Use this network for securing insulation with tie wire or bands.
- 7. Stagger joints between insulation layers at least 3-inches (75 mm).
- 8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
- 9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
- 10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.
- C. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive. Seal longitudinal seams and end joints.
- D. Insulation Installation on Pumps:
 - 1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch (150-mm) centers, starting at corners. Install 3/8-inch- (10-mm-) diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
 - 2. Fabricate boxes from aluminum or stainless steel, at least 0.040-inch (1.0 mm) thick.
 - 3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.7 PIPE INSULATION INSTALLATION

- A. See Part 4 Insulation Schedules for specific requirements.
- B. Requirements in this Article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- C. Insulation Installation on Straight Pipes and Tubes:
 - 1. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. If furnished in half sections, orient longitudinal joints at 3 and 9 o'clock positions on the pipe.
 - 2. All insulation shall be tightly butted and free of voids and gaps at all joints.
 - 3. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 - 4. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6-inches (150 mm) o.c.
 - 5. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant. Vapor barrier must be continuous.
- D. Insulation Installation on Pipe Flanges or Mechanical Couplings:
 - 1. Install preformed pipe insulation to outer diameter of pipe flange or mechanical coupling (such as grooved pipe couplings, if applicable).
 - 2. Make width of insulation section same as overall width of flange/coupling and bolts, plus twice the thickness of pipe insulation, not to exceed 1½-inch (38-mm) thickness.
 - 3. Fill voids between inner circumference of flange/coupling insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same thickness as pipe insulation.
 - 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1-inch (25 mm), and seal joints with flashing sealant.
- E. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 - 2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
 - 3. Cut sectional pipe insulation to fit. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

F. Insulation Installation on Valves, Strainers, Unions, and Specials:

1. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation over valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
4. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
5. Insulate unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
6. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
7. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
8. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

G. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

H. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2-inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

I. Special Requirements for Flexible Elastomeric Insulation Installation: Seal all transverse seams, longitudinal seams, end joints, and section joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 FIELD-APPLIED JACKET INSTALLATION

A. See Part 4 Insulation Schedules for specific requirements.

B. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal

with manufacturer's recommended adhesive. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

- C. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12-inches (300 mm) o.c. and at end joints.

3.9 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous UL-listed fire rating.
- B. Insulate duct access panels and doors to achieve same fire rating as duct.
- C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07 Section "Penetration Firestopping."
- D. All duct systems shall follow "Fire Protection for Laboratories Using Chemicals" in accordance with NFPA 45.
- E. A duct conveying laboratory exhaust that passes through a fire barrier shall provide an alternative means of protection equal to or greater than the rating through which the duct passes in accordance with:
 - 1. Wrapped or encased with listed or approved materials having a fire resistance rating equal to the fire barrier for 10 feet (3 meters) of the duct on each side of the fire barrier including supports within this span.
 - 2. Constructed of materials and supports having a minimum fire resistance rating equal to the fire barrier.
 - 3. Enclosed with a shaft that is constructed of material having a fire resistance rating equal to the fire barrier for 10 feet (3 meters) of the duct on each side of the fire barrier with no inlets to the duct within this distance, and the duct entry into and exit from the shaft is protected in accordance with 4.2.13 of NFPA 91

3.10 FINISHES

- A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- B. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
 - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - 2. Finish Coat Material: Interior, flat, latex-emulsion size.
- C. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- D. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- E. Do not field paint aluminum or stainless-steel jackets.

PART 4 - SCHEDULES

4.1 INSULATION SCHEDULES

- A. Furnish and install duct, equipment, and piping insulation as specified above and in accordance with the schedules below. All insulation thicknesses and pipe sizes in the following tables are given in nominal inches. Where more than one type of allowable material or more than one type of field jacket is listed, the choice is contractor's option.
- B. Hot Surfaces: For piping, ductwork, and equipment services denoted as 105°F or greater, all piping surfaces including but not limited to pipe, duct, flanges, fittings, valves of every kind, pumps, dampers, strainers, unions, steam traps, and other appurtenances shall be insulated to avoid potential for personnel injury via contact with hot surface.
- C. Cold Surfaces: For piping, ductwork, and equipment surfaces operating below surrounding ambient temperature, all surfaces including but not limited to pipe, duct, flanges, fittings, valves of every kind, pumps, dampers, strainers, unions, and other appurtenances shall be insulated and shall include uninterrupted vapor barrier to avoid potential condensation.

DUCT INSULATION		Duct Shape	Duct Location	Minimum R-Value	Allowable Materials	Insulation Thickness	Field Jacket	Keyed Notes
Service								
Supply Air Service (including outdoor air that has been heated or cooled)	Round, Oval	ICC,ICN	R-6	FGBK	2.00	---		
		IEC,IEN	R-6	FGBK	2.00	AL	(3) (6)	
		Outdoors	R-8	FE	(2) 2.00	AL,SS		
	Rectangular	ICC,ICN	R-6	FGBK	1.50	---		
		IEC,IEN	R-6	FGBD	1.50	---	(6)	
		Outdoors	R-8	FE	(2) 2.00	AL,SS		
Outdoor Air Service (prior to being heated or cooled)	Round, Oval	ICC,ICN	R-6	FGBK	2.00	---		
		IEC,IEN	R-6	FGBK	2.00	AL		
		Outdoors	---	---	---	---		
	Rectangular	ICC,ICN	R-6	FGBK	2.00	---		
		IEC,IEN	R-6	FGBD	1.50	---		
		Outdoors	---	---	---	---		
Return Air Service	Round, Oval	ICC,IEC	---	---	---	---		
		ICN	R-6	FGBK	2.00	---		
		IEN	R-6	FGBK	2.00	AL		
		Outdoors	R-8	FE	(2) 2.00	AL,SS		
	Rectangular	ICC,IEC	---	---	---	---		
		ICN	R-6	FGBK	2.00	---		
		IEN	R-6	FGBD	1.50	---		
		Outdoors	R-8	FE	2.00	AL,SS		
Exhaust Air Service	Round, Oval	ICC, IEC	R-3.5	FGBK	1.50	---	(2) (5)	
		ICN, IEN	R-3.5	FGBK	1.50	---	(1) (5)	
		Outdoors	R-8	FGBK,FE	2.00	AL,SS	(1)	
	Rectangular	ICC, IEC	R-3.5	FGBK	1.50	---	(2)	
		ICN, IEN	R-3.5	FGBD	1.50	---	(1)	
		Outdoors	R-8	FE	2.00	AL,SS	(1)	
KEYED NOTES:								
(1) Insulate only if the exhaust is routed to an energy-recovery device.								
(2) Insulate only between final isolation damper and penetration of building exterior.								
(3) The specified field jacket is required on all supply ductwork installed at less than 84-inches AFF and ALL exterior supply ductwork.								
(4) Omit insulation if duct is expressly called out to be internally lined.								
(5) Thickness as required to achieve 2-hour fire rating per NFPA 45.								
(6) Double wall pre-insulated ductwork shall have 1-inch insulation.								
LEGEND:								
ICC Indoor, Concealed, in Conditioned space								
ICN Indoor, Concealed, in Non-conditioned space								
IEC Indoor, Exposed, in Conditioned space								
AL Aluminum								

IEN	Indoor, Exposed, in Non-conditioned space	SS	Stainless Steel
FGBK	Fiberglass Insulation, 1.5-lb density, Blanket		
FGBD	Fiberglass Insulation, 1.5-lb density, Board		
FE	Flexible Elastomeric		
FRW	Fire-Rated Wrap		

EQUIPMENT INSULATION		Service	Location	Size	Allowable Materials	Insulation Thickness	Field Jacket	Keyed Notes
Item / Description								
HVAC Pumps	Chilled Water	Indoors	Any	FE	1.00	AL,SS		
		Outdoors	Any	FE	2.00	AL,SS		
	Heating Water	Indoors	Any	MF	2.00	AL,SS		
		Outdoors	Any	MF	2.00	AL,SS		
Steam System Equipment	Steam and Condensate	Indoors	Any	MF	2.00	AL,SS		
		Outdoors	Any	MF	2.00	AL,SS		
LEGEND:								
		FE	Flexible Elastomeric			AL	Aluminum	
		MF	Mineral Fiber			SS	Stainless Steel	

PIPE INSULATION	Temperature Range °F	Size Range	Location	Allowable Materials	Thick-ness	Field Jacket	Keyed Notes
Services							
Equipment drains, blowdown, hot vents, coil condensate, makeup or fill water	below 60	¾ to 1¼	Indoors	FE	0.50	PVC	(1) (2)
		1½ & up	Indoors	MF	1.00	PVC	(1) (2)
	above 105	All	All	MF	1.50	AL,SS	(1) (2)
Chilled Water Piping (supply and return)	40 and up	¾ to 1¼	Indoors	FE	1.00	PVC	(1) (2)
			Outdoors	FE	2.00	AL,SS	
		1½ to 6	Indoors	FE	1.50	PVC	(1) (2)
			Outdoors	FE	2.00	AL,SS	
		8 & up	Indoors	MF	1.50	PVC	(1) (2)
			Outdoors	MF	2.00	AL,SS	
Heating Hot Water Piping (supply and return) Steam Supply Steam Condensate Return	140 and below	¾ to 1¼	Indoors	FE,MF	1.00	PVC	(1) (2)
		1½ & up	Indoors	FE,MF	1.50	PVC	(1) (2)
		Any	Outdoors	FE,MF	2.00	AL,SS	
	141-200	¾ to 1¼	Indoors	MF	1.50	PVC	(1) (2)
			Outdoors	MF	2.00	AL,SS	
		1½ & up	All	MF	2.00	AL,SS	(1) (2)
	≤15#Steam, & all SCR	¾ to 3½	All	MF	2.50	AL,SS	(1) (2)
		4 & up	All	MF	3.00	AL,SS	(1) (2)
	15.1#Steam to 120#Steam	¾	All	MF	3.00	AL,SS	(1) (2)
		1 & 1¼	All	MF	4.00	AL,SS	(1) (2)
		1½ & up	All	MF	4.50	AL,SS	(1) (2)

KEYED NOTES:

- (1) LAB M702 ALL PIPING SHALL RECEIVE A PVC JACKETING COVER OVER THE INSULATION IN A COLOR APPROVED BY THE ARCHITECT DURING SHOP DRAWING REVIEW PROCESS. FIELD PAINTING OF INSULATED PIPING IS NOT ACCEPTABLE. DO NOT FIELD PAINT IN LAB M702. ALL EXPOSED PIPING IN ALL OTHER SPACES SHALL BE FIELD PAINTED.
- (2) All piping installed from (0 inches) to (72 inches) above finished floor shall have an AL or SS field applied jacketing.

LEGEND:

AFF	Above Finished Floor		
FE	Flexible Elastomeric		
MF	Mineral Fiber	AL	Aluminum
SCR	Steam Condensate Return	HW	Hot Water
PVC	Polyvinyl Chloride	SS	Stainless Steel
		#	psig

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SECTION 230800 - MECHANICAL COMMISSIONING REQUIREMENTS

PART 1 GENERAL

1.1 WORK INCLUDES

- A. Validation of proper installation of Division 23 systems and equipment
- B. Systems and equipment testing and startup
- C. Equipment performance verification
- D. Functional testing of control systems
- E. Documentation of tests, procedures and installations

1.2 SCOPE INCLUDES

- A. Systems to be commissioned include the following:
 - 1. Blower Coil Units
 - 2. Supply and Exhaust Air Terminal Units
 - 3. Supply, General Exhaust, and Fume Hood Exhaust Lab Control Valves
 - 4. Duct Mounted Reheat Coils

1.3 RELATED DOCUMENTS

- A. Commissioning Plan - This plan is part of the Contract Documents and outlines many responsibilities, procedures and tasks throughout the commissioning process.
- B. Section 019113 – General Commissioning Requirements
- C. Section 260800 – Electrical Commissioning Requirements
- D. Division 23 Sections - Individual Sections stipulate installation, startup, warranty and training requirements for the system or device specified in that Section.

1.4 REFERENCES

- A. ASHRAE Guideline 0-2013: The HVAC Commissioning Process.
- B. ANSI/NEBB S110-2019 - Whole Building Technical Commissioning of New Construction

1.5 GENERAL DESCRIPTION

- A. Commissioning is a process to assure all building systems are installed and perform interactively according to the design intent; the systems are efficient, cost effective and meet the Owner's operational needs; the installation is adequately documented. Commissioning serves as a tool to minimize post-occupancy operational problems. It establishes testing and communication protocols in an effort to advance building systems from installation to fully optimized operation.
- B. The Commissioning Authority will work with the Contractor and Design Engineer to coordinate, oversee, and document the commissioning process during the Construction Phase of this project.
- C. This Section defines responsibilities of the Contractor to facilitate the commissioning process particularly during the Construction Phase of the project.

1.6 DEFINITIONS

- A. Refer to specification section 019113 for definitions related to the commissioning process.

1.7 DOCUMENTATION

- A. Contractor shall send Commissioning Authority one copy of the following per the procedures specified in other sections of the Specification:
 - 1. Shop drawings and product data related to systems and equipment to be commissioned on this project. CxA will review and incorporate comments via the Design Engineer.
 - 2. Initial draft of equipment startup plan checklists along with manufacturers' startup procedures. CxA will assist in development and recommend approval.
 - 3. System Test Reports. CxA will review and compile prior to FPT.
 - 4. System certificate of readiness including completed equipment startup forms along with the manufacturers' field or factory performance test documentation. CxA will review and approve prior to FPT.
 - 5. Completed Test and Balance Reports. CxA will review and approve prior to FPT.

1.8 SEQUENCING AND SCHEDULING

- A. Systems can be in various stages of the commissioning process where appropriate, in order to expedite close out of the facility. The CxA and Contractor shall cooperate to schedule Cx tasks to minimize the duration of Cx activities. Sequential priorities shall be followed per the Cx Plan.
- B. Commissioning Schedule - Contractor shall incorporate the commissioning process into the project schedule. Startup, TAB and FPT shall be itemized as applicable for each system. Durations for each task shall be coordinated with the CxA.

1.9 COORDINATION MANAGEMENT PROTOCOLS

- A. Coordination responsibilities and management protocols relative to Cx are initially defined in the Cx Plan but will be refined and documented at the commissioning scoping meeting. Contractor shall have input to the protocols and all parties will commit to scheduling obligations. The CxA will record and distribute notes from the meeting.

1.10 CONTRACTOR RESPONSIBILITIES

- A. Construction Phase
 - 1. Include commissioning requirements in price and plan for work.
 - 2. Attend scoping and coordination meetings scheduled by the CxA.
 - 3. Remedy deficiencies identified during the construction period.
 - 4. Prepare and submit required draft forms and equipment information requested by the CxA. Typically, this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, fan and pump curves, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation, start-up and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the CxA.
 - 5. Assist in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
 - 6. Provide limited assistance to the CxA in preparing the specific functional performance test procedures. Contractors shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
 - 7. Thoroughly complete and inspect installation of systems and equipment in accordance with the Contract Documents, reference or industry standards, and specifically Part 3 of this Section.
 - 8. Startup systems and equipment prior to verification and performance testing by the CxA. Startup procedures shall be in accordance with Contract Documents, reference or industry standards, and specifically Part 3 of this Section.
 - 9. Record startup and test procedures on startup forms and checklists and certify the systems and equipment have been started and tested in accordance with the Contract Documents, reference or industry standards, and specifically Part 3 of this Section. Each form shall be signed and dated by the individual responsible for the startup or test.
 - 10. Complete pre-approved startup checklists and submit along with other installation certification documentation such as certificate of readiness, warranties, test results, etc.
 - 11. Schedule and coordinate Cx efforts required by appropriate subcontractors and vendors.
 - 12. Demonstrate the systems as specified.
 - 13. Certify systems have been installed and are operating per Contract Documents through certificates of readiness.

14. Maintain an updated set of record documentation.
15. Copy CxA on indicated documentation.

B. Acceptance Phase

1. Assist CxA in verification and performance testing. Assistance will generally include the following:
 - a. Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.
 - b. Manipulate systems and equipment to facilitate testing.
 - c. Manipulate control systems to facilitate verification and performance testing.
2. Correct any work not in accordance with Contract Documents and non-conformances included in the commissioning issues log.

C. Warranty Phase

1. Provide warranty service.
2. Correct any deficiencies identified.
3. Update record documentation to reflect any changes made throughout the Warranty Phase.

1.11 CONTROLS CONTRACTOR RESPONSIBILITIES

- A. Sequences of Operation Submittals. The Controls Contractor's submittals of control drawings shall include complete detailed sequences of operation for each piece of equipment, regardless of the completeness and clarity of the sequences in the specifications. They shall include:
1. All interactions and interlocks with other systems.
 2. Detailed delineation of control between any packaged controls and the building automation system, listing what points the BAS monitors only and what BAS points are control points and are adjustable.
 3. Written sequences of control for packaged controlled equipment. (Equipment manufacturers' stock sequences may be included, but will generally require additional narrative).
 4. Start-up sequences.
 5. Warm-up mode sequences.
 6. Normal operating mode sequences.
 7. Unoccupied mode sequences.
 8. Shutdown sequences.
 9. Capacity control sequences and equipment staging.
 10. Temperature and pressure control: setbacks, setups, resets, etc.

11. Detailed sequences for all control strategies, e.g., economizer control, optimum start/stop, staging, optimization, demand limiting, etc.
 12. Effects of power or equipment failure with all standby component functions.
 13. Sequences for all alarms and emergency shut downs.
 14. Seasonal operational differences and recommendations.
 15. Initial and recommended values for all adjustable settings, setpoints and parameters that are typically set or adjusted by operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment.
 16. Schedules, if known.
 17. Include commissioning requirements in price and plan for work.
- B. Assist and cooperate with the CxA in the following manner:
1. Using a skilled technician who is familiar with this building, execute the functional testing of the controls system as specified for the controls. Assist in the functional testing of all equipment specified in Part 3 of this specification.
 2. Execute all control system trend logs specified in Part 3 of this specification.

1.12 CONTRACTOR NOTIFICATION

- A. Contractor shall completely install, thoroughly inspect, startup, test adjust and balance systems and equipment. All activities shall be documented on specified forms. Contractor shall notify Design Engineer, Owner and CxA via the certification of readiness that systems are complete and ready for verification and functional performance testing.
- B. Contractor shall notify CxA at least 10 business days in advance of any tests or startups. CxA shall witness selected tests and startups.

1.13 STARTUP CHECKLISTS

- A. Startup checklists for each type of equipment and system shall be submitted to CxA for approval prior to startup. The forms shall be designed by the appropriate subcontractors or vendors to meet the requirements of the Contract Documents. Forms shall be developed for the specific equipment being installed for this project.
- B. Startup checklists shall generally include the following for each (as applicable):
1. Project specific designation, location and service
 2. Pertinent nameplate data
 3. Indication of the party performing the test
 4. Field for signature of the startup technician along with the date
 5. Clear explanation of the observation, test, measurement, etc. with a pass/fail indication and a record of measurement parameters
 6. Checklist space indicating all O&M instructions, warranties, and record documents have been completed and submitted.

7. Checklist space that proper maintenance clearances have been maintained
 8. Checklist space indicating that any required special tools and/or spare tools were turned over to the Owner
 9. Checklist space indicating that required prerequisite equipment and systems were successfully started.
- C. Startup checklists shall incorporate the manufacturer-specified procedures. Contractor shall compile the startup and checkout procedures indicated in the manufacturer's documentation prior to designing the forms. Include specified acceptance criteria as applicable. The manufacturer's startup and checkout procedures shall be submitted to the CxA along with the draft startup checklists.
- D. Completed startup plans for all pieces of equipment included in a system shall be submitted to CxA prior to verification and performance testing.
- E. See specification 019113 for additional information regarding Startup and Prefunctional Checklists.

1.14 FUNCTIONAL PERFORMANCE TESTING

- A. Participation: CxA will coordinate, test and/or witness functional performance tests after the successful startup and documentation of systems and equipment is complete. Contractor shall assist, as described above, with manipulation of the systems or equipment; provision of supporting equipment or materials (lifts, ladders, specialty test equipment, etc.); and on the spot remediation of minor identified deficiencies.
- B. Detailed Test Forms: CxA will prepare detailed testing procedures and forms to conduct and document the FPT. These will be developed during the Construction Phase and completed during the Acceptance Phase.
- C. Completeness: All systems must be complete and ready for FPT. TAB work must be complete and the control systems must be tested and started for the respective system or component.
- D. Test Documentation: CxA will record test results on the forms developed for the testing. CxA will Pass or Fail the testing and record the date and time of the test. Deficiencies shall clearly indicate when the test has failed. CxA shall recommend acceptance of the system or component after all related testing is successfully complete.
- E. Deficiencies and Retesting: When deficiencies are identified during testing, depending on their extent or magnitude, they can be corrected during the test and the testing can continue to successful completion. Significant deficiencies will fail the test and require retesting of the affected portions of the test. The CxA will subsequently track the resolution of the deficiency via the Project Deficiency List. All tests shall be repeated until successful completion.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 GENERAL

- A. This Section outlines specific startup, checkout, and functional testing requirements for systems and equipment. Generally, these procedures are the direct responsibility of the Contractor as a basic element of validating that the installation is correct. These requirements along with those specified in the individual Section provide a minimum guideline for development of startup procedures, checklists and tests. Contractor shall synthesize these requirements with that of the manufacturer's and/or applicable codes and standards to develop specific and itemized startup procedures specific to that installed on this project.
- B. Refer to all Division 23 Specifications for tests performed on installed equipment and systems.

3.2 STARTUP

- A. The HVAC mechanical and controls contractors shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section and in 019113. The Contractor has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the commissioning authority or Owner.
- B. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the CxA, Contractor, and Owner. Beginning system testing before full completion does not relieve the Contractor from fully completing the system, including all startup plan checklists as soon as possible.

3.3 VALVES – STARTUP/CHECKOUT

- A. Operate all valves, manual and automatic, through their full stroke. Ensure smooth operation through full stroke and appropriate sealing or shutoff.
- B. Verify actuators are properly installed with adequate clearance.

3.4 METERS AND GAUGES – STARTUP/CHECKOUT

- A. Adjust faces of meters and gages to proper angle for best visibility.
- B. Clean windows of meters and gauges and factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touch-up paint. For meters and gauges requiring temporary manual connection of read-out device, such as pressure taps on a flow measuring device, ensure threads are clean and that connection can be made easily.
- C. Meters and gauges requiring manual connection of readout device shall be installed with adequate access to allow connection of device with normal tools.

3.5 MECHANICAL IDENTIFICATION – STARTUP/CHECKOUT

- A. Verify all valve tags, piping, duct and equipment labeling corresponds with drawings and indices and meets required Specifications. Correct any deficiencies for all piping and duct systems.
- B. Adjusting: Relocate any mechanical identification device that becomes visually blocked by work from this Division or other Divisions.
- C. Cleaning: Clean face of identification devices and frames of valve charts.

3.6 MECHANICAL INSULATION – STARTUP/CHECKOUT

- A. Examine all systems and equipment that are specified to be insulated. Patch and repair all insulation damaged after installation. Ensure the integrity of vapor barrier around all cold surfaces.

3.7 PIPING – STARTUP/CHECKOUT

- A. This applies to all piping systems installed including underground site utilities.
- B. Inspect all piping for proper installation; adequate support with appropriate vibration isolation where applicable; and adequate isolation valves for required service.
- C. Flush all piping and clean all strainers.
- D. Ensure adequate drainage is provided at low points and venting is provided at high points. Ensure air is thoroughly removed from the system as applicable.
- E. Ensure all piping is adequately supported and anchored to allow expansion. Bump across the line pumps and inspect for excessive pipe movement.
- F. Pressure and/or leak test all applicable systems in accordance with requirements in Specifications, ASME B31.1, and B31.9 as applicable.
- G. Sterilize applicable piping systems as specified and as required by regulatory authorities.
- H. Submit reports that document the testing results with certification of the results.
- I. Verify the operation of safety relief valves, operating controls, safety controls, etc. to ensure a safe installation.
- J. Set and adjust fill pressure and level controls to the required setting.

3.8 AC MOTORS – STARTUP/CHECKOUT

- A. Verify proper alignment, installation and rotation.
- B. Measure insulation resistance, phase balance, and resistance to ground.

- C. Verify properly sized overloads are in place.
- D. Measure voltage available to all phases. Measure amps and RPM after motor has been placed in operation under load.
- E. Record all motor nameplate data.

3.9 VARIABLE SPEED DRIVES – STARTUP/CHECKOUT

- A. General: Provide the services of a factory-authorized representative to test and inspect equipment installation, provide startup service and to demonstrate and train Owner's personnel.
- B. Startup Checks: Perform the following checks before startup and as specified in manufacturer's startup instructions:
 - 1. Check for shipping damage.
 - 2. Perform a point-to-point continuity test for all field installed wiring interconnections. Verify terminations of field installed wiring.
 - 3. Check for proper torque on connections.
 - 4. Verify use of shielded cable where specified and check that shields have been terminated properly.
 - 5. Verify grounding.
 - 6. Check motor nameplate against drive input rating.
 - 7. Manually rotate motor shaft to ensure free rotation.
 - 8. Check that motor leads are not grounded.
- C. Starting Procedures: Follow the manufacturer's written procedures with the following as a minimum:
 - 1. Ensure device and system which drive is serving is configured to withstand the device operation specified below.
 - 2. Adjust the minimum voltage to enable starting but not to draw excessive power at start.
 - 3. Adjust the Volts/Hz to proper setting.
 - 4. Adjust the acceleration and deceleration rates to the specified times.
 - 5. Adjust current limiting to coordinate with the overcurrent device and protect the motor.
 - 6. Set the maximum and minimum speed.
 - 7. Manually ramp fan speed from minimum to maximum and check for excessive noise and vibration.
 - 8. Determine any critical speeds to avoid and set these in the drive.
 - 9. Verify proper motor rotation in both, Normal and Bypass (if applicable) modes.
 - 10. Record the motor terminal voltage.

11. Verify and document proper setup of redundant drives.
12. Verify and document proper operation of bypasses.

3.10 METAL DUCTWORK – STARTUP/CHECKOUT

- A. Leakage Tests: Refer to Section 233113 Ductwork for duct testing requirements.
- B. Clean ductwork internally of dust and debris unit by unit as it is installed. Clean external surfaces of foreign substances, which might cause corrosive deterioration of metal or where ductwork is to be painted might interfere with painting or cause paint deterioration.
- C. Strip protective paper from stainless ductwork surfaces and repair finish wherever it has been damaged.
- D. Temporary Closure: Provide temporary closure at ends of ducts, which are not connected to equipment or air distribution devices at time of ductwork installation. Use polyethylene film or other covering that will prevent entrance of dust and debris until connections are completed.
- E. Balancing: Refer to Section 230990 Testing, Adjusting, and Balancing for air distribution balancing of metal ductwork. Seal any leaks in ductwork that become apparent in balancing process.

3.11 DUCTWORK ACCESSORIES – STARTUP/CHECKOUT

- A. Operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories as required to obtain proper operation and leak proof performance.
 1. Adjusting: Adjust ductwork accessories for proper settings. Install fusible links in fire dampers and adjust for proper action.
 2. Label access doors in accordance with Division 23 specification sections.
 3. Mark final positioning of manual dampers as specified in Section 230990 Testing, Adjusting, and Balancing.
- B. Fire Damper Testing: For every fire damper, remove the fusible link and verify the damper operates freely and closes tightly. Reinstall the fusible link.
- C. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.12 VAV TERMINAL UNITS – STARTUP/CHECKOUT

- A. Ensure unit is properly supported and that integrity of vibration isolation has been maintained where applicable.
- B. Ensure the air velocity sensor is correctly installed and that inlet/outlet restrictions for accurate measurements have been met.

- C. Ensure air inlet is free of obstructions. Start fans and ensure proper rotation (as applicable).
- D. Measure and record motor amperage and voltage (as applicable).
- E. Install new filters where required.
- F. Calibrate and adjust the airflow control parameters. Set applicable minimum and maximum setpoints. Coordinate with the Building Management System (BMS) contractor as necessary to obtain flow parameters.
- G. Check the heating device and control to ensure functionality and proper installation. Check stroke and range on the valve and ensure it closes and seals tightly. Ensure the coils are undamaged, combed, and vented.
- H. Refer to Section 230593 Testing, Adjusting, and Balancing and coordinate work.

3.13 BLOWER COIL UNITS – STARTUP/CHECKOUT

- A. Inspect the field assembly of components and installation of blower coil units (BCU) including piping, ductwork and electrical connections.
- B. Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Vacuum fan wheel, fan cabinet, and coils entering air face. Ensure volatile irritants are contained and kept out of occupied spaces.
- C. Adjust and lubricate dampers and linkages for proper damper operation.
- D. Ensure field fabricated unit sections are properly connected within acceptable tolerances.
- E. Seal all penetrations air tight and ensure access doors seat tightly.
- F. Verify unit is secure on mountings and supporting devices and connections for piping, ductwork and electrical are complete.
- G. Verify proper thermal overload protection is installed in motors, starters and disconnects.
- H. Ensure vibration isolation integrity and the connections to it are maintained throughout the AHU installation.
- I. Refer to AC Motors in this Section.
- J. Disconnect fan drive from motor and verify proper motor rotation direction; verify fan wheel free rotation; and verify smooth bearing operations. Reconnect fan drive system, align belts and install belt guards. Rotation shall be checked with VFD operating in normal and bypass modes (if applicable).
- K. Lubricate bearings, pulleys, belts and other moving parts with factory-recommended lubricants.
- L. Comb coil fins for parallel orientation.
- M. Install clean filters.

- N. Ensure condensate drains properly and trap is adequate.
- O. Stroke all valves and dampers to ensure free and full travel.
- P. Refer to Section 230593 Testing, Adjusting, and Balancing for detailed requirements for testing, adjusting, and balancing air handling systems.
- Q. Refer to Section 230900 HVAC Instrumentation and Controls for detailed requirements for starting the controls related to the air handling systems.
- R. Training: Train Owner's maintenance personnel on the following:
- S. Procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventative maintenance and how to obtain replacement parts.
- T. Review data in O&M manuals.

3.14 COILS – STARTUP/CHECKOUT

- A. Inspect the field assembly of components and installation of heat exchangers including piping, controls, and electrical connections.
- B. Verify unit is secure on mountings, supporting devices, and connections for piping, controls, and electrical are complete.
- C. Verify adequate access for maintenance.
- D. Check power and control voltages.

3.15 CONTROL SYSTEMS – STARTUP/CHECKOUT

- A. Startup: Refer to Section 230900 HVAC Instrumentation and Controls. This Specification generally requires manufacturer's authorized representative to startup, test, adjust and calibrate DDC control systems and demonstrate compliance with requirements. This includes verification of sequences, normal and emergency operations, calibration, interfaces, interlocks, etc.
- B. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.16 FUNCTIONAL TESTING

- A. This section specifies the functional testing requirements for Division 23 systems and equipment. From these requirements, the Commissioning Authority (CxA) shall develop step-by-step procedures to be executed by the Contractors. The general functional testing process, requirements and test method definitions are described in Section 019113. The test requirements for each piece of equipment or system contain the following:
 - 1. The contractors responsible to execute the tests, under the direction of the CxA
 - 2. A list of the integral components being tested

3. Startup plan checklists associated with the components
4. Functions and modes to be tested
5. Required conditions of the test for each mode
6. Special procedures
7. Required methods of testing
8. Required monitoring
9. Acceptance criteria
10. Sampling strategies allowed

B. PREREQUISITES

The following applicable generic prerequisite checklist items are required to be completed and submitted with the equipment/system certificate of readiness and checked off by CxA prior to functional testing.

1. All related equipment has been started up and startup plan checklists submitted and approved ready for functional testing.
2. All control system functions for this and all interlocking systems are programmed and operable per contract documents, including final setpoints and schedules with debugging, loop tuning and sensor calibrations completed.
3. Piping system flushing complete and required report approved
4. Water treatment system complete and operational
5. Test and balance (TAB) complete and approved for the air and hydronic systems
6. All A/E punchlist items for this equipment corrected
7. Schedules and setpoints provided to the CxA
8. False loading equipment, system and procedures ready.
9. Sufficient clearance around equipment for servicing

C. MONITORING

1. Monitoring is a method of testing as a stand-alone method or to augment manual testing.
2. All points listed in the required monitoring section of the test requirements which are control system monitored points shall be trended by the controls contractor. Other points shall be monitored by the CxA using dataloggers. At the option of the CxA, some control system monitoring may be replaced with datalogger monitoring. At the CxA's request, the controls contractor shall trend up to 20% more points than listed herein at no extra charge.
3. Trend output data must be in a spreadsheet file (Excel or similar) with time continuous down left column and point values in column(s) to the right.
4. All trends for points of a group must start at the same moment in time, unless specifically approved otherwise with the commissioning agent.

3.17 BLOWER COIL UNITS (BCU) FPT

- A. Parties Responsible to Execute Functional Test
1. Controls contractor: operate the controls to activate the equipment as needed.
 2. HVAC mechanical contractor or vendor: assist in testing sequences as needed.
 3. Electrical contractor: perform loss of power testing
 4. Fire alarm contractor: assist in testing sequences as needed.
 5. CxA: to witness, direct and document testing.
- B. Integral Components or Related Equipment Being Tested
1. Unit and components (fans, coils, valves, humidifiers, ducts, VFD)
 2. Heat recovery coil, humidifier or evaporative cooling sections
- C. Prerequisites: The applicable prerequisite checklist items listed in paragraph 3.20.B shall be listed on each certificate of readiness form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the startup plan checklists previously completed by the installer, before the beginning of functional testing.
- D. Functions / Modes Required to Be Tested, Test Methods and Seasonal Test Requirements: The following testing requirements are an addition to and do not replace any testing requirements elsewhere in this Division.

<u>Function / Mode</u>	<u>Test Method</u> Manual, Monitoring, Either or Both ³	<u>Required</u> <u>Seasonal</u> <u>Test</u> ¹
General		
1. Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, shutdown, unoccupied & manual modes and power failure. Test functionality of this piece of equipment or system in all control strategies or interlocks with which it is associated.	Manual	
In addition to, or as part of (1) above, the following modes or tests are required:		
2. Supply air temperature control functions.	Both	Both
3. Fan interlocks.	Either	
4. No Cooling when there is Heating	Both	
5. VFD operation on SF: modulation to minimum, control system PID, constancy of static pressure, verification of program settings, alarms, etc.	Both	²
6. Damper interlocks and correct modulation in all modes	Manual	
7. Temperature difference across CC per specifications.	Manual	
8. Verify TAB reported SF cfm with control system reading.	Manual	²
9. All alarms (low limits, high static, etc.).	Manual	
10. Sensor and actuator calibration checks: Duct static pressure sensor, SAT, MAT, OSAT, OSA & RA damper and valve positions, SF cfm reading with TAB, and other random checks (BAS readout against hand-held calibrated instrument or observation must be within specified tolerances)	Manual	
11. Verify schedules and setpoints to be reasonable, appropriate, and		

<u>Function / Mode</u>	<u>Test Method</u> Manual, Monitoring, Either or Both ³	<u>Required</u> <u>Seasonal</u> <u>Test</u> ¹
coordinated with the Owner's Project Requirements.		

¹Design cooling season, heating season or both. "Design" means within 5°F of season design or 95% of loading design. A blank cell denotes no special seasonal test is required and that test can be executed during any season, if condition simulation is appropriate.

²Seasonal test not required if seasonal conditions can be adequately simulated.

³Refer to Special Procedures

E. Special Procedures or Conditions

1. None

F. Required Monitoring

1. All points listed below that are control system monitored points shall be trended by the controls contractor. Other points shall be monitored by the CxA using dataloggers. Refer to the Monitoring section at paragraph 3.20.C for additional monitoring details.

Point	Time Step (min.)	Minimum Time Period of Trend
For each BCU being tested:		
SAT and SAT setpoint	10	7 days
ZN-T and ZN-T setpoint	10	7 days
SF speed, if variable, else status	10	7 days
CCV position	10	7 days

G. Acceptance Criteria

1. For the conditions, sequences and modes tested, the BCU, integral components, and related equipment respond to varying loads and changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.
2. BCU with supporting systems shall be able to maintain the SA temperature within 1.0°F of either side of the deadband of the current setpoint without excessive hunting.
3. Space temperatures shall average within +/- 1°F of setpoint and always remain within 1°F of the ends of the deadband without excessive hunting of coil valve/heating demand, or complaints of drafts or stuffiness from occupants.
4. BCU system and controls shall maintain the space temperature and humidity within the parameters defined in the Contract Documents.

END OF REQUIREMENTS FOR BCU TEST

3.18 TERMINAL UNITS FPT

A. Parties Responsible to Execute Functional Test

1. Controls contractor: operate the controls to activate the equipment.
 2. HVAC mechanical contractor or vendor: assist in testing sequences.
 3. CxA: to witness, direct and document testing.
- B. Integral Components or Related Equipment Being Tested
1. Supply and Exhaust Variable Air Volume Terminal unit
 2. Supply, General Exhaust, and Fume Hood Exhaust Lab Control valve
 3. Duct Mounted Reheat Coil
- C. Prerequisites: The applicable prerequisite checklist items listed in paragraph 3.22.B shall be listed on each certificate of readiness form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the startup plan checklists previously completed by the installer, before the beginning of functional testing.
- D. Functions / Modes Required to Be Tested, Test Methods and Seasonal Test Requirements: The following testing requirements are an addition to and do not replace any testing requirements elsewhere in this Division.

<u>Function / Mode</u>	<u>Test Method</u> Manual, Monitoring, Either or Both ¹	<u>Required Seasonal Test</u> ²
General		
1 Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, warmup, shutdown, unoccupied & manual modes and power failure and restoration. Test functionality of this piece of equipment or system in all control strategies or interlocks that it is associated with, including all damper, valve and fan functions.	Manual	
In addition to, or as part of (1) above, the following modes or tests are required:		
2 Sensor activator calibration checks on: DAT, zone air temperature, damper position and other random checks (BAS readout against visual or hand-held calibrated instrument must be within 0.5°F for temps. or within a tolerance equal to 10% of static pressure setpoint)	Manual	
3 Verify control parameters and setpoints to be reasonable and appropriate by reviewing the full program of all the TU's with each other for consistency. Verify the max. and min. cfm setpoints of all TU's against the control drawing and TAB values.	Observation	
4 Verify no hunting or significant overshoot by damper or valves.	Either	
5 All alarms (fan status, low limits, high static, etc.)	Manual	
6 Verify that TU is maintaining space setpoint temperatures	Monitoring	Both Design

¹Design cooling season, heating season or both. "Design" means within 5°F of season design or 95% of loading design. A blank cell denotes no special seasonal test is required and that test can be executed during any season, if condition simulation is appropriate.

²Seasonal test not required if seasonal conditions can be adequately simulated.

³Refer to Special Procedures

E. Special Procedures or Conditions

1. None

F. Required Monitoring

1. All points listed below which are control system monitored points shall be trended by the controls contractor. Other points shall be monitored by the CxA using dataloggers. Refer to the Monitoring section at paragraph 3.22.C for additional monitoring details

Point	Time Step (min.)	Minimum Time Period of Trend
For each zone thermostat and space sensor and other critical areas, monitor:		
Space temperature (summer design)	10	7 days
Space temperature (winter design)	10	7 days
Heating coil valve/heating command	10	7 days
Damper position and cfm	10	7 days

G. Acceptance Criteria

1. For the conditions, sequences and modes tested, the TU, integral components and related equipment respond to varying loads and changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.
2. Space temperature during occupied modes shall average within +/- 1°F of setpoint and always remain within 1°F of the ends of the deadband without excessive hunting of either the damper or coil valve/heating demand, or complaints of drafts or stuffiness from occupants.

END OF REQUIREMENTS FOR TERMINAL UNIT TEST

3.19 TEST AND BALANCE WORK (TAB)

A. Parties Responsible to Execute Functional Test

1. TAB contractor: perform checks using test instruments.
2. Controls contractor: operate the controls to activate the equipment.
3. CxA: to witness, direct and document testing.

B. Integral Components or Related Equipment Being Tested

1. TAB air-side

C. Prerequisites: The applicable prerequisite checklist items listed in paragraph 3.20.B shall be listed on each certificate of readiness form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the startup

plan checklists previously completed by the installer, before the beginning of functional testing.

- D. Purpose. The purpose of this test is to spot check the TAB work to verify that it was done in accordance with the contract documents and acceptable practice and that the TAB report is accurate.
- E. The following tests and checks will be conducted. The following testing requirements are in addition to and do not replace any testing requirements elsewhere in this Division.

Test or Check	Test Method
1. A random sample of up to 10% the TAB report data shall be selected for verification (air velocity, air or water flow rate, pressure differential, electrical measurement, etc.). The original TAB contractor will execute the checks, witnessed by the commissioning authority. The TAB contractor will use the same test instruments as used in the original TAB work. A failure¹ of more than 10% of the selected items of a given system² shall result in the failure of acceptance of the system TAB report and the TAB contractor shall be responsible to rebalance the system in its entirety, provide a new system TAB report and repeat random verifications of the new TAB report.	Demonstration
2. Verify that final settings of all valves, dampers and other adjustment devices have been permanently marked by the TAB Contractor.	Demonstration
3. Verify that the air system is being controlled to the lowest possible static pressure while still meeting design loads, less diversity. This shall include a review of TAB methods, control setpoints established by TAB and a physical verification of at least one leg from fan to diffuser having all balancing dampers wide open and that during full cooling of all TUs taking off downstream of the static pressure sensor, the TU on the critical leg has its damper 90% or more open.	Demonstration

¹Failure of an item is defined as follows:

For air flow of supply and return: a deviation of more than 10% of instrument reading

For minimum outside air flow: 20% of instrument reading

For temperatures: a deviation of more than 1°F

For air and water pressures: a deviation of more than 10% of full scale of test instrument reading

²Examples of a "system" are: the air distribution system served by one air handler or the hydronic chilled water supply system served by a chiller or the condenser water system. Systems can be defined as smaller parts if inaccuracies in TAB work within the smaller defined system will have little or no impact on connected systems.

F. Special Procedures or Conditions

1. Rechecking shall be limited to either 10% of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

G. Required Monitoring

1. None

H. Acceptance Criteria

1. Provided in footnote to test table above.

END OF REQUIREMENTS FOR TAB TEST

END OF SECTION 230800

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SECTION 23 0900 - CONTROL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

- A. University of Missouri Controls Specification.
- B. This section contains requirements for pneumatic, electric and digital control systems as indicated on the contract drawings.
- C. Contractor is responsible for providing, installing and connecting all sensors, pneumatic actuators, control valves, control dampers, electrical components and all interconnecting pneumatic tubing and electrical wiring between these devices and up to the Direct Digital Controller (DDC).
- D. DDC systems consist of Johnson Controls METASYS controllers. Contractor shall install owner provided control enclosures. Owner will provide and install controllers. After all equipment has been installed, wired and piped, Owner will be responsible for all termination connections at the DDC controller's and for checking, testing, programming and start-up of the control system. Contractor must be on site at start-up to make any necessary hardware adjustments as required.
- E. Once each mechanical system is completely operational under the new control system, contractor shall make any final connections and adjustments. For controls renovation jobs, contractor shall remove all unused sensors, operators, panels, wiring, tubing, conduit, etc. Owner shall have the option of retaining any removed pneumatic controls.

1.02 RELATED SECTIONS

- A. Drawings and general provisions of Contract, including General and Special Conditions apply to work of this section.

1.03 QUALITY ASSURANCE

- A. Contractor's Qualifications:
 - 1. Contractor shall be regularly engaged in the installation of digital control systems and equipment, of types and sizes required. Contractor shall have a minimum of five years' experience installing digital control systems. Contractor shall supply sufficient and competent supervision and personnel throughout the project in accordance with General Condition's section 3.4.1 and 3.4.4.
- B. Codes and Standards:
 - 1. Electrical Standards: Provide electrical components of control systems which have been UL-listed and labeled, and comply with NEMA standards.
 - 2. NEMA Compliance: Comply with NEMA standards pertaining to components and devices for control systems.
 - 3. NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences.
 - 4. NFPA Compliance: Comply with NFPA 70 "National Electric Code."

1.04 SUBMITTALS

- A. Shop Drawings: Submit shop drawings for each control system, containing the following information:
- B. Product data for each damper, valve, and control device.
- C. Schematic flow diagrams of system showing fans, pumps, coils, dampers, valves, and control devices.
- D. Label each control device with setting or adjustable range of control.
- E. Indicate all required electrical wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
- F. Provide details of faces on control panels, including controls, instruments, and labeling.
- G. Include written description of sequence of operation.
- H. Provide wiring diagrams of contractor provided interface and I/O panels.
- I. Provide field routing of proposed network bus diagram listing all devices on bus.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Air Piping:
 - 1. Copper Tubing: Seamless copper tubing, Type M or L, ASTM B 88; wrought-copper solder-joint fittings, ANSI B16.22; except brass compression-type fittings at connections to equipment.
 - 2. Flex Tubing: Virgin Polyethylene non-metallic tubing, ASTM D 2737, with flame-retardant harness for multiple tubing. Use compression or push-on polyethylene fittings. Tubing used above suspended ceilings to be plenum rated per NFPA 90A. See section 3.1.b for locations where flex tubing can be used.
 - 3. Copper to polyethylene connections shall be compression barbed fittings or solder barbed fittings.
- B. Conduit and Raceway:
 - 1. Electrical Metallic Tubing: EMT and fittings shall conform to ANSI C80.3.
 - 2. Surface Metal Raceway and Fittings: Wiremold 500, Ivory, or approved equal.
 - 3. Flexible Metal Conduit: Indoors, per National Electric Code for connection to moving or vibrating

- equipment.
- 4. Liquidtight Flexible Conduit: Outdoors, per National Electric Code for connection to moving or vibrating equipment.
- C. Control Valves: Provide factory fabricated pneumatic or electric control valves of type, body material, and pressure class as indicated on the drawings. Butterfly style control valves are not acceptable except for two position applications. Equip control valves with heavy-duty actuators, with proper shutoff rating for each individual application.
 - 1. Steam and Hot Water
 - a) Manufacturer: Do not allow KMC valves and actuators.
 - b) Water Service Valves: Equal percentage characteristics.
 - c) Steam Service Valves: Equal percentage characteristics.
 - d) Single Seated Valves: Cage type trim, providing seating and guiding surfaces for plug on "top and bottom" guided plugs.
 - e) Valve Trim and Stems: Polished stainless steel.
 - f) Packing: Spring-loaded Teflon, self-adjusting.
 - g) Control valves should have a minimum 100 psi close-off rating for chilled water applications.
 - 2. Hydronic Chilled Water and Heating Water
 - a) At minimum, hydronic control valves shall be pressure independent. High performing energy monitoring control valves may be considered depending on the project. The flow through the valve shall not vary more than +/- 5% due to system pressure fluctuations across the valve in the selected operating range. The control valve shall accurately control the flow from 1 to 100% full rated flow.
 - b) The valve bodies shall be of cast iron, steel or bronze and rated for 150 PSI working pressure. All internal parts shall be stainless steel, steel, Teflon, brass, or bronze.
 - c) DeltaP Valves manufactured by Flow Control Industries, Belimo, Danfoss Series, or approved equal.
 - d) The valves shall have pressure taps across the valve for measuring the pressure drop across the valve. The pressure taps shall have 1/2-inch extensions for accessibility.
 - e) Control valves shall be installed with unions or flanges as necessary for easy removal and replacement.
 - f) Valve Tag shall include the model number, AHU being served, design flow, and maximum flow for that valve.
 - g) The control valves shall be delivered preset to the scheduled design flow and should be capable of reaching 110% of the design flow to allow for field adjustment for capacity changes.
- D. Control Dampers: Ruskin CD-50 or approved equal.
 - 1. Provide dampers with parallel blades for 2- position control.
 - 2. Provide opposed blades for modulating control.
 - 3. Dampers shall be low leakage design with blade and edge seals.
 - 4. Provide multiple sections and operators as required by opening size and sequence of operations, as indicated on the contract drawings.
- E. Electric Actuators: Johnson Controls, Bray, Belimo, TAC or approved equal. KMC actuators are not approved. Size electric actuators to operate their appropriate dampers or valves with sufficient reserve power to provide smooth modulating action or 2-position action as specified. If mixed air AHU has return air, exhaust air and outside air dampers that are not mechanically linked then static safety switch must be installed and wired to safety circuit. Spring return actuators should be provided on heat exchanger control valves or dampers or as specified on the drawings. Control signal shall be 0 to 10 VDC unless otherwise specified on drawings. Actuators with integral damper end switch are acceptable. For VAV reheat valves, actuators shall have a manual override capability to aid in system flushing, startup, and balancing.
- F. Air and Hot Water Electronic Temperature Sensors:
 - 1. All electronic temperature sensors shall be compatible with Johnson METASYS systems.
 - 2. Sensors shall be 1,000 ohm platinum, resistance temperature detectors (RTDs) with two wire connections. Duct mounted sensors shall be averaging type. Contractor may install probe type when field conditions prohibit averaging type, but must receive permission from Owner's Representative.

3. Coordinate thermowell manufacturer with RTD manufacturer. Thermowells that are installed by the contractor, but are to have the RTD installed by owner, must be Johnson Controls Inc. series WZ-1000.
- G. Electronic Temperature Sensors and Transmitters:
1. Chilled Water, Tower Water, Heating Hot Water, and Steam Temperature Sensors
 - a) General: The RTD/Temperature Transmitter/Thermowell assembly shall come as a complete assembly from a single manufacturer. The Assembly shall be suitable for use in the accurate measurement of Chilled/Tower/Hot Water and steam temperatures in a mechanical room environment.
 - b) Calibration: Each RTD must be match calibrated to the Transmitter via NIST traceable calibration standards. Results are to be programmed into the transmitter. Results are to be presented on report as after condition at the specified calibration points. Assembly shall not be approved for installation until Owner has received all factory calibration reports.
 - c) RTD:
 - (1) RTD type: 2-wire or 3-wire 100 ohm platinum class A
 - (2) Outside Diameter: 0.25 inch
 - (3) Tolerance: +/- 0.06% Type A
 - (4) Stability: +/- 0.1 % over one year.
 - (5) TCR: 0.00385 (ohm/ohm/°C).
 - (6) RTD shall be tip sensitive.
 - (7) Resistance vs. Temperature table for the RTD must be provided to the Owner.
 - d) Transmitter:
 - (1) Transmitter shall be match calibrated to the RTD and assembled as a matched pair.
 - (2) Type: 2 wire (loop powered)
 - (3) Input: 2 or 3 wire 100 ohm platinum class A or class B RTD
 - (4) Output: Output shall be a 4-20 mA signal linear to temperature
 - (5) Calibrated Span:
 - (a) Chilled Water: 30 °F to 130 °F.
 - (b) Tower Water: 30 °F to 130 °F.
 - (c) Hot Water: 100 °F to 250 °F.
 - (d) Steam: 150 °F to 450 °F
 - (6) Calibration Accuracy, including total of all errors, of the Transmitter & RTD matched pair over the entire span shall be within +/- 0.2% of the calibrated span or +/- 0.18 °F, whichever is greater.
 - (7) Supply Voltage: 24 VDC.
 - (8) Ambient Operating Temp.: 32 to 122 °F
 - (9) Epoxy potted for moisture resistance.
 - (10) Mounting: Transmitter shall be mounted in the RTD connection head.
 - e) Thermowell
 - (1) Thermowell shall be suitable for immersion in chilled/hot water and steam.
 - (2) Thermowell shall be reduced tip.
 - (3) Thermowell shall be one piece stainless steel machined from solid bar stock.
 - (4) Thermowell shall have 1/2" NPT process connection to pipe thread-o-let.
 - (5) Thermowell Insertion depth shall be ½ the inside pipe diameter but not to exceed 10".
 - f) Assembly:
 - (1) Assembly configuration: Spring loaded RTD with thermowell-double ended hex-connection head.
 - (2) Connection head shall be cast aluminum with chain connecting cap to body, have 1/2" NPT process and 3/4" NPT conduit connections, and a sealing gasket between cap and body.
 - g) RTD/Temperature Transmitter/Thermowell assembly shall be the following or approved equal:
 - (1) Manufacturer: Pyromation, Inc.
 - (2) Chilled Water: RAF185L-S4C[length code]08-SL-8HN31,TT440-385U-S(30-130)F with calibration SMC(40,60)F
 - (3) Tower Water: RAF185L-S4C[length code]08-SL-8HN31,TT440-385U-S(5130)F with calibration SMC(55,85)F
 - (4) Hot Water: RAF185L-S4C[length code]08T2-SL-8HN31,TT440-385U-S(100-250)F

- with calibration SMC(140,180)F
(5) Steam: RAT185H-S4C[length code]08T2-SL-8HN31,TT440-385U-S(150-450)F with calibration SMC(300,350)F

- H. Occupant Override: Provide wall mounted occupant override button in locations shown on drawings.
- I. Low Limit Controllers: Provide unit-mounted low limit controllers, of rod-and-tube type, with an adjustable set point and a manual reset. Capillary shall be of adequate length to horizontally traverse face of cooling coil every 12". Multiple low limit controllers may be required for large coils. Controller shall have an extra set of contactors for connection to control panel for alarm status. Locate the thermostat case and bellows where the ambient temperature is always warmer than the set point.
 - 1. Freeze Stats: Johnson Controls model A70HA-1 or approved equal.
- J. Humidistats: Humidistats must be contamination resistant, capable of $\pm 2\%$ RH accuracy, have field adjustable calibration and provide a linear proportional signal.
 - 1. HD20K-T91 or equivalent.
- K. Humidity High Limit
 - 1. Multi-function device that can function as a high limit or proportional override humidity controller, as stand-alone proportional controller, or a stand-alone two-position controller.
 - a) Johnson Controls TRUERH HL-67N5-8N00P or approved equal.
- L. Carbon Dioxide Sensor:
 - 1. Wall Mount: ACI Model ESENSE-R.
 - 2. Duct Mount: ACI Model ESENSE-D.
- M. Fan/Pump Status: Status points for fan or pump motors with a VFD must be connected to the terminal strip of the VFD for status indication.

Current switches: Current switches are required for fan and pump statuses that are not connected to a VFD. The switches must have an adjustable trip setpoint with LED indication and be capable of detecting broken belts or couplings. Units shall be powered by monitored line, UL listed and CE certified, and have a five year warranty.

 - 1. Kele, Hawkeye or approved equal.
- N. Relays Used for Fan and Pump Start/Stop: Must have LED indication and be mounted externally of starter enclosure or VFD.
 - 1. Kele, RIBU1C or approved equal.
- O. Power Supply Used to Provide Power to Contractor-Provided Control Devices: Shall have adjustable DC output, screw terminals, overload protection and 24 VAC and 24 VDC output.
 - 1. Kele, DCPA-1.2 or approved equal.
- P. Pressure Differential Switch:
 - 1. Fans: NECC model DP222 or approved equal.
- Q. Differential Pressure Transmitter: Provide units with linear analog 4-20mA output proportional to differential pressure, compatible with the Johnson METASYS Systems.
 - 1. Water: Units shall be wet/wet differential pressure capable of a bi-directional pressure range of ± 50 psid. Accuracy shall be $\pm 0.25\%$ full scale with a compensated temperature range of 30 to 150 deg F and a maximum working pressure of 250 psig.
 - 2. Install transmitter in a pre-manufactured assembly with shut off valves, vent valves and a bypass valve.
 - a) Setra model 230 with Kele model 3-VLV, three valve manifold or approved equal.
 - 3. Air: Units shall be capable of measuring a differential pressure of 0 to 5 in. WC. Accuracy shall be $\pm 1.0\%$ full scale with a compensated temperature range of 40 to 149 deg F and a maximum working pressure of 250 psig.
 - a) Setra model MRG or approved equal.
 - b) Shall be installed in control panel and piped 2/3 down the duct unless shown otherwise or approved by owners representative.
- R. Building Static Pressure: Transducer shall utilize a ceramic capacitive sensing element to provide a stable linear output over the specified range of building static pressure. Transducer shall be housed in a wall-mounted enclosure with LCD display. Transducer shall have the following capabilities:
 - 1. Input Power: 24 VAC
 - 2. Output: 0-10 VDC
 - 3. Pressure Range: -0.25 to +0.25 inches w.g.
 - 4. Display: 3-1/2 digit LCD, displaying pressure in inches w.g.
 - 5. Accuracy: $\pm 1.0\%$ combined linearity and hysteresis
 - 6. Temperature effect: 0.05% / deg C
 - 7. Zero drift (1 year): 2.0% max
 - 8. Zero adjust: Push-button auto-zero and digital input
 - 9. Operating Environment: 0 to 140 deg F, 90% RH (non-condensing)

10. Fittings: Brass barbs, 1/8" O.D.
 11. Enclosure: High-impact ABS plastic
 12. Outside Air Sensor Pickup Port: UV stabilized thermoplastic or aluminum "can" enclosure to shield outdoor pressure sensing tube from wind effects. BAPI ZPS-ACC10-rooftop mount, wall mount, or equivalent.
 13. Transducer shall be Veris Industries Model PXPLX01S, equivalent from Setra, or approved equal.
- S. High Static Pressure Limit Switch: Provide pressure high limit switch to open contact in fan circuit to shut down the supply fan when the inlet static pressure rises above the set point. Provide with an adjustable set point, a manual reset button, 2 SPST (normally closed) contacts, and 1/4" compression fittings.
1. Kele model AFS-460-DDS, or approved equal.

PART 3 EXECUTION

3.01 INSTALLATION OF CONTROL SYSTEMS

- A. General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings.
- B. Control Air Piping:
1. All control air piping shall be copper. Exception: Flexible Tubing may be used for a maximum of two (2) feet at connections to equipment [except for steam control valves] and inside control cabinets.
 2. Provide copper tubing with a maximum unsupported length of 3'-0".
 3. Pressure Test control air piping at 30 psi for 24 hours. Test fails if more than 5 PSI loss occurs.
 4. Fasten flexible connections bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support tubing neatly.
 5. Number-code or color-code tubing, except local individual room control tubing, for future identification and servicing of control system.
 6. All control tubing at control panel shall be tagged and labeled during installation to assist owner in making termination connections at control panel.
 7. Provide pressure gages on each output device.
 8. Paint all exposed control tubing to match existing.
- C. Raceway: Raceway is to be installed in accordance with the National Electric Code. Use of flexible metal conduit or liquidtight flexible conduit is limited to 36" to connect from EMT to devices subject to movement. Flexible raceway is not to be used to compensate for misalignment of raceway during installation.
- D. Control Wiring: Install control wiring in raceway, without splices between terminal points, color-coded. Install in a neat workmanlike manner, securely fastened. Install in accordance with National Electrical Code.
1. Install circuits over 25-volt with color-coded No. 12 stranded wire.
 2. Install electronic circuits and circuits under 25-volts with color-coded No. 18 stranded twisted shielded pair type conductor.
 3. N2 communications bus wire shall be 18 AWG, plenum rated, stranded twisted shielded, 3 conductor, with blue outer casing, described as 18-03 OAS STR PLNM NEON BLU JK distributed by Windy City Wire, constructed by Cable-Tek, or approved equivalent.
 - a) Metastat wiring shall be minimum 20 AWG, plenum rated, stranded, 8 conductor stranded wire.
 4. FC communications bus wire shall be 22 AWG, plenum rated, stranded twisted shielded, 3 conductor, with blue outer casing, described as 22-03 OAS STR PLNM NEON BLU JK distributed by Windy City Wire, constructed by Cable-Tek, or approved equivalent.
 - a) Network sensor wiring (SA Bus) shall be 22 gauge plenum rated stranded twisted wire, 4 conductor.
 5. All control wiring at control panel shall be tagged and labeled during installation to assist owner in making termination connections at control panel. Label all control wires per bid documents.
- E. All low voltage electrical wiring shall be run as follows:
1. Route electrical wiring in concealed spaces and mechanical rooms whenever possible.
 2. Provide EMT conduit and fittings in mechanical rooms and where indicated on drawings.
 3. Low voltage electrical wiring routed above acoustical ceiling is not required to be in conduit, but wire must be plenum rated and properly supported to building structure.
 4. Provide surface raceway, fittings and boxes in finished areas where wiring cannot be run in concealed spaces. Route on ceiling or along walls as close to ceiling as possible. Run raceway parallel to walls. Diagonal runs are not permitted. Paint raceway and fittings to match existing conditions. Patch/repair/paint any exposed wall penetrations to match existing conditions.
- F. All devices shall be mounted appropriately for the intended service and location.

1. Adjustable thermostats shall be provided with base and covers in occupied areas and mounted 48" above finished floor to the top of the device. Tubing and/or wiring shall be concealed within the wall up to the ceiling where ever possible. Surface raceway may only be used with approval of Owners Representative. Wall mounted sensors such as CO2, RH, and non-adjustable temperature sensors shall be mounted 54" above finished floor. Duct mounted sensors shall be provided with mounting brackets to accommodate insulation. Mounting clips for capillary tubes for averaging sensors are required.
2. All control devices shall be tagged and labeled for future identification and servicing of control system.
3. Preheat and mixed air discharge sensors must be of adequate length and installed with capillary tube horizontally traversing face of coil, covering entire coil every 24 inches bottom to top.
4. All other air sensors located in AHU's shall be of adequate length to cover every 36" of the air flow path.
5. All field devices must be accessible or access panels must be installed.
- G. Install magnehelic pressure gage across each air handling unit filter bank. If the air handling unit has a prefilter and a final filter, two magnehelic pressure gages are required.

3.02 ADJUSTING AND START-UP

- A. Start-Up: Temporary control of Air Handling Units shall be allowed only if approved by the owner's representative to protect finishes, etc., AHUs may be run using caution with temporary controls installed by contractor early in the startup process. All safeties including a smoke detector for shut down must be operational. Some means of discharge air control shall be utilized and provided by the contractor such as a temporary temperature sensor and controller located and installed by the Contractor.
- B. The start-up, testing, and adjusting of pneumatic and digital control systems will be conducted by owner. Once all items are completed by the Contractor for each system, Contractor shall allow time in the construction schedule for owner to complete commissioning of controls before project substantial completion. This task should be included in the original schedule and updated to include the allotted time necessary to complete it. As a minimum, the following items are required to be completed by the Contractor for Owner to begin controls commissioning.
 1. Process Control Network
 - a) The control boards and enclosures need to be installed in the mechanical rooms.
 - b) The fiber optic conduit and box for the process control network needs to be installed. Once in place, Owner needs to be contacted so the length of the owner provided fiber cable can be determined and ordered, if required. Coordinate with Owner to schedule the pull in and termination of the fiber cable. Power should be in place at that time. (Fiber for the process control network is required to allow metering of utilities prior to turn on.)
 2. Heating System
 - a) Pumps, heat exchangers, steam pressure reducing station, piping, control valves, steam and/or hot water meter, feeder conduit and wire, VFDs, control panels and control wiring installed in the mechanical room. The house keeping pads must be poured before pump operation. All must be in place in working order (pumps aligned, VFDs set up by vendor, motors checked for rotation, steam regulators set to required pressure, condensate pumps operational, heating system ready to circulate (all piping pressure tested, flushed, and insulated) with differential pressure sensors in place.
 3. Cooling System
 - a) Pumps, heat exchangers, piping, control valves, chilled water meter, feeder conduit and wire, VFDs, control panels and control wiring installed in the mechanical room. The house keeping pads must be poured before pump operation. All must be in place in working order (pumps aligned, VFDs set up by vendor, motors checked for rotation, cooling system ready to circulate (all piping pressure tested, flushed, and insulated) with differential pressure sensors in place.
 4. VAVs-First Pass
 - a) Power, (FC or N2 bus), and control wire installed before owner can make first commissioning pass. First pass includes installation of VAV controller, termination of power, control and network communication wiring.
 5. Air Handlers
 - a) Prior to owner commissioning, at a minimum, the following items shall be complete: Power wiring, motor rotation check, fire/smoke dampers open, control wiring including all safeties, IO cabinet, air handler cleaned, and filters installed as required. To protect the systems from dirt, outside air with no return will be used until the building is clean enough for return air operation.
 6. VAVs-Second Pass
 - a) After the air handlers are running and under static pressure control and the heating water

system is operating, a second pass can be made on the VAVs to download the control program and commission controllers to verify the VAV dampers, thermostat, and reheat control valves are working properly.

7. Exhaust and Energy Recovery Systems
 - a) Exhaust fans need to be operational and under control before labs can be commissioned.
8. Lab Air Controls
 - a) Lab Air Controls vendor will have the same requirements as stated above for VAVs.
9. Some balance work can be done alongside the control work as long as areas are mostly complete and all diffusers are in place.

3.03 CLOSEOUT PROCEDURES

- A. Contractor shall provide complete diagrams of the control system including flow diagrams with each control device labeled, a diagram showing the termination connections, and an explanation of the control sequence. The diagram and sequence shall be framed and protected by glass and mounted next to controller.
- B. Contractor shall provide as built diagram of network bus routing listing all devices on bus, once wiring is complete prior to scope completion.

• END OF SECTION

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SECTION 230990 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 230100 "Basic Mechanical Requirements" and Section 230500 "Basic Mechanical Materials and Methods" apply to the work of this Section as if fully repeated herein.

1.2 DESCRIPTION OF WORK

- A. This scope of services specifies the requirements and procedures for mechanical systems testing, adjusting and balancing. Requirements include measurement and establishment of the fluid quantities of the mechanical systems as required to meet design specifications, and recording and reporting the results. The test and balance work will be performed by the Owner's personnel. It is the Contractor's responsibility to assist as outlined below.
- B. Test, adjust and balance the following mechanical systems which are shown in the construction documents.
 - 1. Supply air systems, all pressure ranges, including variable volume and constant volume systems.
 - 2. Return air systems.
 - 3. Outdoor air systems.
 - 4. Exhaust air systems.
 - 5. Hydronic systems.
 - 6. Domestic hot water recirculating system.
 - 7. Steam distribution systems.
 - 8. Verify temperature control system operation.
 - 9. Laboratory systems.
- C. The Contractor's responsibilities are as follows:
 - 1. Notify the Owner's Representative fourteen (14) days prior to the schedule date for balancing the system.
 - 2. Schedule a four (4) week allowance for the testing and balancing to complete the testing and balancing work when scheduling completion of all work required of the Contractor by the contract documents.
 - 3. Cooperate with the testing and balancing firm and shall make all necessary preparations for the TAB efforts.
 - 4. Complete the following work prior to requesting the TAB effort.
 - a. Clean and flush all piping systems.
 - b. Leak test and make tight all piping systems.
 - c. Fill all piping systems with clean water.
 - d. Clean and seal all ductwork systems.
 - e. Service and tag all equipment.
 - f. Set and align all motors and drives.
 - g. Start up and prove all equipment and systems.
 - h. Make preliminary settings on all control devices and have all systems operational.
 - i. Operate all systems successfully for twenty-four (24) hours minimum.
 - 5. Lubricate all motors and bearings.
 - 6. Check fan belt tension.
 - 7. Check fan rotation.
 - 8. Patch insulation, ductwork and housing, using materials identical to those removed.
 - 9. Seal ducts and piping, and test for and repair leaks.
 - 10. Seal insulation to re-establish integrity of the vapor barrier.
 - 11. Attend a coordination meeting prior to the balancing of the system and a coordination meeting following the balancing of the system.
 - 12. Provide a complete set of as-built drawings prior to the TAB effort.
 - 13. Provide craftsmen of the proper trade to work with the TAB firm to make adjustments and installation changes as required.
 - 14. Change out fan sheaves when and if required by the TAB firm.
 - 15. Dedicate the resources to accommodate all changes identified by the test and balance firm in a timely manner.
 - 16. If a significant rebalance (Owner's determination) of the HVAC system is required due to the Contractor's failure to properly install and check out the HVAC system, the cost of rebalancing the system shall be borne by the Contractor.

1.3 PRE-BALANCING CONFERENCE

- A. Prior to beginning of the testing, adjusting and balancing procedures, a conference with the Owner's representative, Engineer and the Test and Balance Agency's representative will be held. The objective of the conference is final coordination and verification of system operation and readiness for testing, adjusting and balancing.

1.4 SEQUENCING AND SCHEDULING OF SERVICES

- A. Test, adjust and balance the air conditioning systems during summer season and heating systems during winter season. This includes at least a period of operation at outside conditions within 5 deg. F wet bulb temperature of maximum summer design condition, and within 10 deg. F dry bulb temperature of minimum winter design conditions. Take final temperature readings during seasonal operation.

PART 2 - PRODUCTS (Not applicable)

PART 3 - EXECUTION (Not applicable)

END OF SECTION 230990

SECTION 23 2113 – HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
 - 1. Hot-water heating piping.
 - 2. Chilled-water piping.
 - 3. Makeup-water piping.
 - 4. Condensate-drain piping.
 - 5. Air-vent piping.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 23 0100 "Basic Mechanical Requirements," and Section 23 0500 "Basic Mechanical Materials and Methods" all apply to the work of this Section as if fully repeated herein.
- C. The following Sections contain requirements that relate to this Section:
 - 1. Division 07 Section "Penetration Firestopping" for materials and methods for sealing pipe penetrations through fire and smoke barriers.
 - 2. Division 07 Section "Joint Sealants" for materials and methods for sealing pipe penetrations through exterior walls.
 - 3. Division 23 Section "Basic Mechanical Materials and Methods" for general piping materials and installation requirements, and for labeling and identifying hydronic piping.
 - 4. Division 23 Section "Hangers and Supports" for pipe supports, product descriptions, and installation requirements. Hanger and support spacing is specified in this Section.
 - 5. Division 23 Section "Valves" for general-duty gate, globe, ball, butterfly, and check valves.
 - 6. Division 23 Section "Meters and Gages" for thermometers, flow meters, and pressure gages.
 - 7. Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.
 - 8. Division 23 Section "Control Systems" for temperature-control valves and sensors.

1.3 DEFINITIONS

- A. The following definitions apply to the work of this Section. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for additional definitions.
 - 1. CPVC: Chlorinated polyvinyl chloride.
 - 2. CWP: Cold working pressure (formerly WOG – Water, Oil, Gas working pressure).
 - 3. DZR Brass: Brass alloy containing not more than 15% zinc by weight.
 - 4. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 5. PTFE: Polytetrafluoroethylene.
 - 6. PVC: Polyvinyl chloride.
 - 7. SWP: Steam working pressure.
 - 8. Pipe sizes used in this Specification are Nominal Pipe Size (NPS).
 - 9. Class 125: Minimum 125-psig (860-kPa) SWP and minimum 200-psig (1380-kPa) CWP ratings.
 - 10. Class 150: Minimum 150-psig (1035-kPa) SWP and minimum 300-psig (2070-kPa) CWP ratings.

1.4 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:
 - 1. Hot-Water Heating Piping: 150 psig (1030 kPa) at 200°F (93°C).
 - 2. Chilled-Water Piping: 150 psig (1030 kPa) at 200°F (93°C).
 - 3. Condenser-Water Piping: 175 psig (1200 kPa) at 150°F (66°C).
 - 4. Glycol Cooling-Water Piping: 175 psig (1200 kPa) at 150°F (66°C).
 - 5. Makeup-Water Piping: 80 psig (552 kPa) at 150°F (66°C).
 - 6. Condensate-Drain Piping: 150°F (66°C).
 - 7. Blowdown-Drain Piping: 200°F (93°C).
 - 8. Air-Vent Piping: 200°F (93°C).
 - 9. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

1.5 SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Plastic pipe and fittings with solvent cement.
 - 2. Pressure-seal fittings.
 - 3. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and active flow-limiting valves.
 - 4. Air control devices.
 - 5. Chemical treatment.
 - 6. Hydronic specialties.
- B. Shop Drawings: Detail, at ¼-inch = 1-foot 0-inch (1:50) scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
- C. Qualification Data: For Installer.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
- B. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air/dirt separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- E. Comply with NFPA 70 – National Electrical Code. Do not route piping directly above electric panelboards and switchboards, or other prohibited locations.

1.7 COORDINATION

- A. Coordinate layout and installation of hydronic piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
- B. Coordinate pipe sleeve installations for foundation wall penetrations.
- C. Coordinate piping installation with roof curbs, equipment supports, and roof penetrations. Roof specialties are specified in Division 07 Sections.
- D. Coordinate pipe fitting pressure classes with products specified in related Sections.
- E. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 03 Sections.
- F. Coordinate installation of pipe sleeves for penetrations through exterior walls and floor assemblies. Coordinate with requirements for firestopping specified in Division 07 Section "Penetration Firestopping" for fire and smoke wall and floor assemblies.

1.8 EXTRA MATERIALS

- A. Water-Treatment Chemicals: Furnish enough chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.
- B. Differential Pressure Meter: For each type of balancing valve and active flow limiting valve, include flowmeter, probes, hoses, flow charts, and carrying case.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Plastic Ball, Butterfly, and Check Valves:
 - a. Asahi/America.
 - b. Hayward Industrial Products, Inc.
 - c. Nibco Inc.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Calibrated Balancing Valves:
 - a. Armstrong Pumps, Inc.
 - b. Bell & Gossett; a Xylem Brand
 - c. Hydronic Components, Inc.
 - d. IMI – TA/Victaulic.
 - e. Nibco Inc.
3. Active Flow-Limiting Valves:
 - a. Bell & Gossett; a Xylem Brand
 - b. Griswold Controls.
 - c. Hydronic Components, Inc.
 - d. IMI Flow Design.
 - e. Nexus Valve.
 - f. Nibco Inc.
 - g. Pro-Hydronic Specialties, LLC.
4. Pressure-Reducing Valves and Safety Valves:
 - a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Bell & Gossett; a Xylem Brand.
 - d. Conbraco Industries, Inc.
 - e. Spence Engineering Company, Inc.
 - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
5. Manual Air Vents:
 - a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Bell & Gossett; a Xylem Brand.
 - d. Spriotherm, Inc.
 - e. Taco.
6. Automatic Air Vents:
 - a. Spirotherm Spirotop Air Release Valve only.
7. Strainers:
 - a. Armstrong Machine Works.
 - b. Eaton Filtration.
 - c. Hoffman Specialty ITT; Fluid Handling Div.
 - d. Metraflex Co.
 - e. Nibco Inc.
 - f. Spirax Sarco.
 - g. Watts Regulator Co.

2.2 PIPING MATERIALS

A. General: Refer to Part 3 "Piping Applications" Article for applications of pipe and fitting materials, including a schedule of which types of piping to use in which application.

2.3 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B88, Type L (ASTM B88M, Type B).

- B. Annealed-Temper Copper Tubing: ASTM B88, Type K (ASTM B88M, Type A).
- C. DWV Copper Tubing: ASTM B306, Type DWV.
- D. Wrought-Copper Fittings and Unions: ASME B16.22.
- E. Solder Filler Metals: ASTM B32, 95-5 tin antimony.

2.4 STEEL PIPE AND FITTINGS

- A. Steel Pipe, NPS 2 (DN 50) and smaller: ASTM A53/A53M, black steel with plain ends; Type F (furnace butt-welded), Grade A, Schedule 40; unless otherwise indicated in Part 3 "Piping Applications" Article.
- B. Steel Pipe: NPS 2½ (DN 65) and larger: ASTM A53/A53M, black steel with plain ends; Type E (electric-resistance welded), Grade B, Schedule 40; unless otherwise indicated in Part 3 "Piping Applications" Article.
- C. Steel Pipe Nipples: ASTM A733, made of ASTM A53/A53M black steel, Grade B, Schedule 40; unless otherwise indicated in Part 3 "Piping Applications" Article.
- D. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150 or 300 as indicated in Part 3 "Piping Applications" Article.
- E. Malleable-Iron Unions: ASME B16.39; Class 150, 250, or 300 as indicated in Part 3 "Piping Applications" Article.
- F. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Class 125 or 250 as indicated in Part 3 "Piping Applications" Article; raised ground face, and bolt holes spot faced.
- G. Wrought-Steel Fittings: ASTM A234/A234M, wall thickness to match adjoining pipe. All elbows shall be long-radius type.
- H. Wrought Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of Material Group 1.1, butt-weld end connections, and raised facings.
- I. Integrally Reinforced Forged Branch Outlet Fittings: Comply fully with MSS SP-97, latest edition, except where made more restrictive herein. The branch connection must reinforce the opening and restore the original strength of the run pipe. The deposited weld metal used to attach the fittings to run pipes shall contain all the reinforcement required by the ASME B31.1 and ASME B31.3 piping codes without the addition of saddles or pads. Example of acceptable product is "Threadolet®" and "Weldolet®" by Bonney Forge.

2.5 PLASTIC PIPE AND FITTINGS

- A. CPVC Plastic Pipe: ASTM F441/F 441M, Schedule 40 or 80 as indicated in Part 3 "Piping Applications" Article, plain ends.
- B. CPVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM F438 for Schedule 40 pipe; ASTM F439 for Schedule 80 pipe. CPVC solvent cement shall meet ASTM F493.

2.6 SPECIALTIES

- A. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for joining materials, transition fittings, and dielectric fittings. Those requirements apply to the work of this Section as if fully reproduced herein.

2.7 GENERAL-PURPOSE VALVES

- A. Refer to Division 23 Section "Valves" for Gate, Globe, Check, Ball, and Butterfly Valves, whose requirements apply to the work of this Section as if fully reproduced herein.
- B. Refer to Division 23 Section "Control Systems" for Automatic Temperature-Control Valves, Actuators, and Sensors, whose requirements apply to the work of this Section as if fully reproduced herein.
- C. Refer to Part 3 "Valve Applications" Article elsewhere within this Section for applications of each type of valve and service.
- D. Calibrated Balancing Valves:
 - 1. General: Multi-turn y-pattern plug-style or globe-style valve with calibrated orifice or venturi.
 - 2. Body (Size ½-inch NPS): Bronze, brass, or DZR-brass body with threaded ends.
 - 3. Body (Size ¾-inch to 2-inch NPS): Bronze or DZR-brass body with threaded ends.
 - 4. Body (Size 2½-inch NPS and larger): Painted cast-iron or steel body with flanged or grooved ends.
 - 5. Plug: Resin.
 - 6. Seat/Packing: PTFE or TFE.
 - 7. Stem Seals: EPDM O-rings.
 - 8. Disc: Glass and carbon-filled PTFE.
 - 9. Pressure Gage Connections: Integral seals for portable differential pressure meter.
 - 10. Handle Style: Multi-turn dial, handle, or similar multi-turn adjustment device for manual position adjustment with memory stop to retain set position.
 - 11. Accessories: Integral pointer and calibrated scale to register degree of valve opening.

12. Pressure and Temperature Rating: Same as piping in which it will be installed, as specified in Part 1 of this Section.

E. Active Flow-Limiting Valves:

1. Body: DZR-brass or ferrous metal.
2. Piston and Spring Assembly: Bronze or Stainless steel; tamper proof, self-cleaning, and removable.
3. Combination Assemblies: Include bronze or brass-alloy ball valve.
4. Identification Tag: Marked with zone identification, valve number, and flow rate.
5. Pressure and Temperature Rating: Same as piping in which it will be installed, as specified in Part 1 of this Section.
6. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.

2.8 AIR CONTROL DEVICES

- A. Manual Air Vents: Bronze body, nonferrous internal parts, operated via manual screwdriver or thumbscrew. NPS ½ (DN 15) inlet connection and NPS 1/8 (DN 6) discharge connection. CWP rating shall be 150 psig (1035 kPa) and rated operating temperature shall be 225°F (107 C).
- B. Automatic Air Vents: Bronze or cast iron body, nonferrous internal parts, operated via noncorrosive metal float. NPS ½ (DN 15) inlet connection and NPS ¼ (DN 8) discharge connection. CWP rating shall be 150 psig (1035 kPa) and rated operating temperature shall be 240°F (116 C).

2.9 HYDRONIC PIPING SPECIALTIES

- A. Y-Pattern Strainers, 2-inch and Smaller:
 1. Body (for use in Copper piping): ASTM B584 C84400 or ASTM B-62 C83600 bronze body, with threaded bronze cover and brass drain plug.
 2. Body (for use in Steel piping): ASTM A126, Class B, cast iron with threaded cap and bottom drain connection.
 3. End Connections: Threaded ends.
 4. Strainer Screen: 20-mesh, Type 304 stainless steel.
 5. Pressure and Temperature Rating: Same as piping in which it will be installed, as specified in Part 1 of this Section.
- B. Y-Pattern Strainers, 2½-inch and Larger:
 1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
 2. End Connections: Flanged ends.
 3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
 4. Pressure and Temperature Rating: Same as piping in which it will be installed, as specified in Part 1 of this Section.
- C. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for Flexible Pipe Connectors, whose requirements apply to the work of this Section as if fully reproduced herein.

PART 3 - EXECUTION

3.1 PIPING SCHEDULE OF APPLICATIONS

- A. Hot-water heating piping, Chilled-water piping, Condenser-water piping, aboveground, NPS 2 (DN 50) and smaller, shall be Type L (C), drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
 1. Contractor's Option: Schedule 40 steel pipe; Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints will be acceptable.
- B. Hot-water heating piping, Chilled-water piping, Condenser-water piping, aboveground, NPS 2½ (DN 65) and larger, shall be Standard Weight steel pipe; wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints. All elbows shall be long-radius type.
- C. Hot-water heating piping, Chilled-water piping, Condenser-water piping, NPS 2 (DN 50) and smaller installed belowground and within slabs shall be Type K (A), annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.
- D. Makeup-water piping installed aboveground shall be Type L (B), drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- E. Makeup-Water Piping Installed Belowground and within Slabs shall be Type K (A), annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.

- F. Cooling Coil Condensate-Drain Piping: Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints; or Schedule 40 CPVC plastic pipe and fittings and solvent-cemented joints.
- G. Other hydronic heating system drains (blowdown, overflow, etc.): Use same materials and joining methods as for hot-water heating piping described above.
- H. Chiller or other chilled-water system drains (blowdown, overflow, etc.): Use same materials and joining methods as for chilled-water piping described above; or use Schedule 40 CPVC plastic pipe and fittings and solvent-cemented joints.
- I. Air-Vent Piping: Same materials and joining methods as for piping specified for the service in which air vent is installed.
- J. Contractor's Option: Type L (C), drawn-temper copper tubing with Pressure-Seal fittings and joints will be acceptable where soldered copper is specified above, but only where piping is exposed to view or located above a fully-accessible lay-in ceiling.
- K. Other HVAC-Related Piping Applications:
 - 1. Chemical Treatment Piping: Type L (C), drawn-temper copper tubing, wrought-copper fittings, and soldered joints, or Schedule 40 CPVC plastic pipe and fittings and solvent-cemented joints, as recommended by chemical treatment provider.

3.2 VALVE APPLICATIONS

- A. Install valves where indicated on Drawings and where indicated in Division 23 Section "Valves."
- B. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
- C. Install specialty valves where indicated on Drawings.
- D. Install drain valves at all low points, and manual air vents at all high points, in mains, risers, branch lines and elsewhere as required for system drainage.
- E. Any valve that represents a termination or the end of a run (e.g., blowdown or drain valve, hose-end valve, etc.) shall be fitted with a permanent but removable cap, plug, or blind flange matching the valve construction, to minimize risk in the event the valve is accidentally opened under pressure.

3.3 PIPING INSTALLATIONS

- A. General: General piping installation is specified in Division 23 Section "Basic Mechanical Materials and Methods," whose requirements apply to the work of this Section as if fully repeated herein.
- B. Install drains, consisting of a tee fitting, NPS ¾ (DN 20) ball valve, and short NPS ¾ (DN 20) threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- C. In closed systems, install horizontal piping at a uniform grade of 0.2 percent upward in direction of flow.
- D. For cooling coil condensate-drain piping, install horizontal piping at a uniform grade of 1.0 percent downward in the direction of flow.
- E. Bull-head tees prohibited: Do not use tee fittings in such a way that the flow through the branch leg equals the sum of the flows through two main legs.
- F. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- G. Contractor has the option, without further approval from the Engineer, to install piping of larger (but not smaller) nominal diameter from that shown on the Drawings. For example, if 5-inch NPS is shown on the Drawings, contractor may furnish and install 6-inch NPS piping at no additional cost to the Owner; but may NOT furnish and install 4-inch NPS piping if 5-inch is indicated.
- H. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the top of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- I. Changes of direction, branches, tees, etc. shall be accomplished with the appropriate factory or foundry fitting meeting the requirements of these specifications. Mechanically-formed extruded tee outlets or field-fabricated tee branches and/or elbows are not acceptable.
 - 1. Integrally Reinforced Forged Branch Outlet Fittings will be accepted only for pipe main sizes of 2½-inch and larger with a branch nominal diameter not greater than 50% of the run nominal diameter (not greater than a 4-inch branch for an 8-inch run, for example). Install per manufacturer's written instructions.
- J. All elbows shall be long-radius type.
- K. Install valves according to Division 23 Section "Valves."
- L. Install unions in piping NPS 2 (DN 50) and smaller, at final connections of equipment and elsewhere as indicated.
- M. Install flanges in piping NPS 2½ (DN 65) and larger, at final connections of equipment and elsewhere as indicated.

- N. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS ¾ (DN 20) nipple and ball valve in blowdown connection of strainers NPS 2 (DN 50) and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2 (DN 50).
- O. Install and anchor piping to allow for proper length and direction of expansion and contraction.
- P. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.
- Q. Install expansion joints, anchors, and pipe alignment guides as specified in Division 23 Section "Pipe Expansion Fittings."
- R. Identify piping as specified in Division 23 Section "Basic Mechanical Materials and Methods."
- S. Hang, support, and anchor all piping as specified in Division 23 Section "Hangers and Supports."

3.4 PIPE JOINT CONSTRUCTION

- A. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for joint construction requirements for soldered joints in copper tubing; threaded, welded, and flanged joints in steel piping; and solvent-welded joints for PVC and CPVC piping.
- B. Welded Joints: Construct joints according to AWS D10.12, "Recommended Practices and Procedures for Welding Low Carbon Steel Pipe," using qualified processes and welding operators according to "Quality Assurance" Article.
 - 1. Apply one coat of self-priming, rust-inhibitor paint around the entire circumference of each welded pipe joint; regardless of whether or not the piping is specified to be painted. Paint may be brush-applied, roller-applied, or spray-applied at contractor's option.
- C. Pressure-Sealed Joints: Use manufacturer-recommended crimping tool and procedure. Leave insertion marks on pipe after assembly.

3.5 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
- B. Install automatic air vents where indicated on Drawings. Air vents shall be provided at all system high points. This includes all high points in both the supply and return piping wherever the piping changes elevations. All air vents in a system shall be manual vents except Install a ball valve and automatic vent at all locations shown on drawings. All automatic air vents shall be preceded by a manual ball valve and piped to nearest floor drain. Route air vent discharge in minimum size 0.25-inch in copper piping to nearest floor drain.

3.6 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install control valves in accessible locations close to connected equipment, but outside the service area. For example, control valve shall be as close to hydronic coil as practical, but not within the coil pull space and/or access door swing space.
- C. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 23 Section "Meters and Gages."

3.7 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
 - 1. Leave joints, including welds, uninsulated and exposed for examination during test.
 - 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 - 3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
 - 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
 - 5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- B. Perform the following tests on hydronic piping:
 - 1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used. Do not pressure test with air.

2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. Minimum duration of test shall be four (4) hours. During the final hour of the hydrostatic test, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

3.8 CLEANING AND ADJUSTING

- A. Mark calibrated nameplates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.
- B. Flush hydronic piping systems with clean water. Remove and clean or replace strainer screens. After cleaning and flushing hydronic piping systems, but before balancing, remove disposable fine-mesh strainers in pump suction diffusers.

END OF SECTION 23 2113

SECTION 23 3113 – METAL DUCTS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes metal ducts and plenums for supply, return, outside, and exhaust air-distribution systems in pressure classes from minus 2- to plus 10-inch wg (minus 500 to plus 2500 Pa). Metal ducts include the following:
 - 1. Single-wall rectangular ducts and fittings.
 - 2. Single-wall round and flat-oval ducts and fittings.
 - 3. Double-wall round and flat-oval ducts and fittings.
 - 4. Factory Pre-Insulated Duct Systems ducts and fittings.
 - 5. Sheet metal materials.
 - 6. Sealants and gaskets.
 - 7. Hangers and supports.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 23 0100 "Basic Mechanical Requirements," and Section 23 0500 "Basic Mechanical Materials and Methods" all apply to the work of this Section as if fully repeated herein.
- C. The following Sections contain requirements that relate to this Section:
 - 1. Division 07 Sections "Penetration Firestopping" for fire-resistant sealants for use around duct penetrations and fire-damper installations in fire-rated floors, partitions, and walls.
 - 2. Division 08 Section "Access Doors and Frames" for wall- and ceiling-mounted access doors and for access to concealed ducts.
 - 3. Division 08 Section "Louvers and Vents" for intake and relief louvers and vents connected to ducts and installed in exterior walls.
 - 4. Division 23 Section "Mechanical Insulation."
 - 5. Division 23 Section "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
 - 6. Division 23 Section "Air Terminals" for temperature control terminal units.
 - 7. Division 23 Section "Diffusers, Registers and Grilles."
 - 8. Division 23 Section "Control Systems" for automatic control dampers and actuators.
 - 9. Division 23 Section "Testing, Adjusting and Balancing" for air balancing and final adjusting of manual volume dampers.

1.03 DEFINITIONS

- A. Thermal Conductivity and Apparent Thermal Conductivity (k-Value): As defined in ASTM C168.

1.04 PERFORMANCE REQUIREMENTS

- A. Duct system design, as indicated, has been used to select size and type of air-moving and distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by the design professional. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.
- B. Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA *HVAC Duct Construction Standards – Metal and Flexible* and performance requirements and design criteria indicated in Part 3 of this Section.
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2016.

1.05 SUBMITTALS

- A. Product Data: For each type of the following products:
 - 1. Sealants and gaskets.
 - 2. Manufactured ductwork and duct fittings (if applicable).
 - 3. MSDS (Material Safety Data Sheet) for each adhesive and sealant furnished.
 - 4. Sheet metal thicknesses.
 - 5. Joint and seam construction and sealing.

6. Reinforcement details and spacing.
7. Materials, fabrication, assembly, and spacing of hangers and supports.

- B. Coordination Drawings: Comply with Division 23 Section "Basic Mechanical Requirements" for Coordination Drawings.
- C. Field quality-control test reports: Indicate and interpret test results for compliance with performance requirements.
- D. Record Drawings: Indicate actual routing, fitting details, reinforcement, support, and installed accessories and devices.

1.06 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 1. AWS D1.1/D1.1M, "Structural Welding Code – Steel," for hangers and supports.
 2. AWS D1.2/D1.2M, "Structural Welding Code – Aluminum," for aluminum supports.
 3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. NFPA Compliance: Comply with NFPA 90A-2018 *Standard for the Installation of Air Conditioning and Ventilating Systems*.
- C. AMCA Compliance: All spiral ducts shall bear the AMCA Certified Ratings Program seal for Air Leakage.
- D. ASHRAE Compliance: Applicable requirements in ASHRAE Standard 62.1-2016, Section 5 - "Systems and Equipment" and Section 7 – "Construction and System Start-Up."
- E. ASHRAE Compliance: Applicable requirements in ASHRAE Standard 90.1-2016, Section 6.4.4 – "HVAC System Construction and Insulation."

1.07 REFERENCES

- A. ANSI/SMACNA Standard 016-2012 *HVAC Air Duct Leakage Test Manual*, as published by the Sheet Metal and Air Conditioning Contractors' National Association. 2nd ed. Chantilly, VA: SMACNA, 2012. All references to this document throughout this Section refer to this specific edition.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver sealant and firestopping materials to site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.
- B. Store and handle sealant and firestopping materials according to manufacturer's written recommendations.
- C. Deliver and store stainless-steel sheets with mill-applied adhesive protective paper maintained through fabrication and installation.
- D. Factory Pre-Insulated Duct Systems: Installers are required to inspect all Factory Pre-Insulated Duct System products received at time of delivery to verify if any of the pieces have been damaged during shipment. Recipient of damaged goods must notate damage on transportation company shipping documentation with delivery driver's signature. Installer will be deemed to have accepted the System unless it notifies the Manufacturer in writing within 24 hours of delivery with written evidence of damage including photographs.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Factory Pre-Insulated Duct Systems:
 - a. Thermaduct, LLC (outdoor round and rectangular ducts).
 - b. or approved equal.
 2. Flexible Elastomeric Duct Liner:
 - a. Aeroflex USA Inc.
 - b. Armacell LLC.
 - c. Rubatex International, LLC
 3. Field-Applied Duct Sealant Materials:
 - a. Ductmate, Inc.
 - b. H.B. Fuller Construction Products Inc. (Childers and/or Foster brands)
 - c. Hardcast, Inc.
 - d. McGill Air Seal Corporation.

4. Optional Manufactured Duct Slide-on Flange System:

- a. Ductmate, Inc.
- b. Nexus Inc.
- c. Ward Industries, Inc.

5. Optional Round Duct Coupling System:

- a. Lindab, Inc. "Spirosafe"
- b. Sheet Metal Connectors, Inc.
- c. Spiramir Corp.
- d. Stamped Fittings Inc. "The Edge"

2.02 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA *HVAC Duct Construction Standards – Metal and Flexible* for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Sheet Gage: SMACNA standards notwithstanding, no material thinner than 26-gage is permitted for spiral-seam round duct, and no material thinner than 24-gage is permitted for all other ducts.
- C. Galvanized Sheet Steel: Comply with ASTM A653 / A653M.
 - 1. Galvanized Coating Designation: G90 (Z275).
 - 2. Finishes for Surfaces Exposed to View: Mill-phosphatized.
- D. Stainless-Steel Sheets: Comply with ASTM A480 / A480M, Type 304 or 316, as indicated in Part 3 of this Section; cold rolled, annealed, sheet. Surface finish shall be No. 4 where exposed to view and No. 2B where concealed.
- E. Aluminum Sheets: Comply with ASTM B209 (ASTM B209M) Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- F. Reinforcement Shapes and Plates: ASTM A36 / A36M, steel plates, shapes, and bars; black and galvanized. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- G. Tie Rods: Comply with Articles 2.5 through 2.9, including all accompanying Tables and Figures, of the SMANCA HVAC Duct Construction Standards.

2.03 SEALANT MATERIALS

- A. Two-Part Sealing System: Woven-fiber tape impregnated with gypsum mineral compound and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal; Hardcast® Two-Part Sealing System, Uni-Cast® by McGill AirSeal Corporation, or equal.
- B. One-Part Sealing System: Flexible, adhesive sealant, fiber-reinforced, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts. Examples of acceptable products include Uni-Mastic 181 by McGill, Foster 32-19, and Childers CP-146.
- C. Water-Based Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.
- D. Formed-on Duct Connectors: Flange shop roll-formed onto edge of ductwork, with corner closures, cleats and gaskets for seal; TDC or TDF constructed per SMACNA T-25a or T-25b.
 - 1. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C920, Type S, Grade NS, Class 25, Use O.
 - 2. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.
 - 3. Contractor's Option: Proprietary manufactured slide-on duct connectors by Ductmate, Ward, or Nexus meeting the above requirements will be accepted wherever formed-on duct connectors are required by these specifications.

2.04 RECTANGULAR DUCT FABRICATION

- A. General: Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA *HVAC Duct Construction Standards – Metal and Flexible*. Comply with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, deflection limits, and joint types and intervals, except where more stringent requirements are specified herein.
- B. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.
- C. Materials: Free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.

- D. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches (480 mm) and larger and 0.0359-inch (0.9 mm) thick or less, with more than 10 sq. ft. (0.93 sq. m) of unbraced panel area, unless ducts are lined.
- E. Pressure Classification: See Schedule in Part 3 of this Section.
- F. Seal Classification: See Schedule in Part 3 of this Section.
- G. Longitudinal Seams: Contractor's choice of Pittsburgh lock (SMACNA Figure 2-2 Type L-1) or Button Punch Snap Lock (SMACNA Figure 2-2 Type L-2) shall be used on all longitudinal seams. See "Seam and Joint Sealing" in Part 3 of this Section for further requirements.
- H. Duct sizes shown on plans are free area sizes and do not include the thickness of internal duct liner, if any. For internally lined ductwork, increase the indicated duct dimensions to account for the liner thickness.
- I. Contractor is free to alter the indicated sizes of rectangular duct to suit field conditions, provided that revised size is selected for friction loss no greater than that of indicated size. No prior approval by the Engineer is required for equal-friction duct size changes unless proposed size has an aspect ratio greater than 4 to 1.
- J. All changes of direction shall be fabricated as elbows in accordance with SMACNA Figure 4-2 except that RE-4, RE-9 and RE-10 are prohibited. RE-6 is limited to a change-of-direction angle of 45 degrees or less.
- K. Divided flow branches shall be Type 1 or Type 2 per SMACNA Figure 4-5. Type 3 divided flow branches are permitted only where expressly shown. Seek Engineer's approval of Type 3 where space and/or layout clearances prohibit Type 1 or Type 2.
- L. Branch connections shall be per SMACNA Figure 4-6, except that straight taps are not permitted on any ducts 2-inch pressure class or above. Straight-tap "spin-in" fittings are permitted on ½-inch and 1-inch pressure class ductwork only.
- M. Offsets and transitions shall be per SMACNA Figure 4-7, except that offset Type 2 (mitered) is limited to an angle of 45° or less.
- N. Fittings at obstructions shall be per SMACNA Figure 4-8, except that Figure D is not permitted. Use Figure 4-8.B in lieu of Figure 4-8.D. Seek Engineer's approval of Figure 4-8.D where space and/or layout clearances prohibit use of Figure 4-8.B.

2.05 ROUND AND FLAT-OVAL DUCT AND FITTING FABRICATION

- A. Diameter as applied to flat-oval ducts in this Section is the diameter of a round duct with a circumference equal to the perimeter of a given size of flat-oval duct.
- B. Contractor's Option: The contractor is permitted to furnish spiral lock-seam round or flat-oval ductwork anywhere rectangular duct is indicated, provided the Contractor's coordination drawings demonstrate that adequate ceiling clearances and space required by other trades will permit round ductwork. If this option is chosen, round duct sizes shall be selected by the Contractor according to "equal friction" with respect to the rectangular sizes shown.
- C. Round, Spiral Lock-Seam Ducts: Fabricate supply ducts of galvanized steel according to SMACNA *HVAC Duct Construction Standards – Metal and Flexible* is the thinnest material acceptable.
- D. Longitudinal-seam round ducts ("stovepipe") of a minimum 24-gage thickness, will be permitted on ½-inch and 1-inch pressure classifications only; and only if the Seal Class specified in Part 3 of this Section can be achieved.
- E. Flat-Oval, Spiral Lock-Seam Ducts: Fabricate supply ducts according to SMACNA *HVAC Duct Construction Standards – Metal and Flexible* except that 24-gage is the thinnest material available. With approval of Engineer, contractor may substitute flat oval duct where round duct is indicated, provided that revised size is selected for friction loss no greater than that of indicated size.
- F. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA *HVAC Duct Construction Standards – Metal and Flexible*, with metal thicknesses specified for longitudinal-seam straight ducts.
- G. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.
- H. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows shall be 1½ times duct diameter. Adjustable-angle elbow fittings are not permitted. Unless elbow construction type is indicated, fabricate elbows as follows:
 - 1. Flat-Oval Mitered Elbows: Welded construction with same metal thickness as longitudinal-seam flat-oval duct.
 - 2. 90-Degree, 2-Piece, Mitered Elbows: Use only if approved by the Engineer where space restrictions do not permit using radius elbows. Fabricate with turning vanes.
 - 3. Round Elbows 8 Inches (200 mm) and Less in Diameter: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.

4. Round Elbows 9 through 14 Inches (225 through 355 mm) in Diameter: Fabricate gored or pleated elbows for 30, 45, 60, and 90 degrees unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
5. Round Elbows Larger Than 14 Inches (355 mm) in Diameter and All Flat-Oval Elbows: Fabricate gored elbows unless space restrictions require mitered elbows.

2.06 DOUBLE-WALL DUCT AND FITTING FABRICATION

- A. Ducts: Fabricate double-wall (insulated) ducts with an outer shell and an inner duct. Dimensions indicated are for inner ducts.
1. Outer Shell: Base metal thickness on outer-shell dimensions. Fabricate outer-shell lengths 2 inches (50 mm) longer than inner duct and insulation and in metal thickness specified for single-wall duct.
 2. Insulation: 1-inch- (25-mm) thick fibrous glass, unless otherwise indicated. Terminate insulation where double-wall duct connects to single-wall duct or uninsulated components, and reduce outer shell diameter to inner duct diameter.
 - a. Thermal Conductivity (k-Value): 0.26 at 75°F (0.037 at 24 C) mean temperature.
 3. Solid Inner Ducts: Use the following sheet metal thicknesses and seam construction:
 - a. Ducts 3 to 8 Inches (75 to 200 mm) in Diameter: 0.019 inch (0.5 mm) with standard spiral-seam construction.
 - b. Ducts 9 to 42 Inches (225 to 1070 mm) in Diameter: 0.019 inch (0.5 mm) with single-rib spiral-seam construction.
 - c. Ducts 44 to 60 Inches (1120 to 1525 mm) in Diameter: 0.022 inch (0.55 mm) with single-rib spiral-seam construction.
 - d. Ducts 62 to 88 Inches (1575 to 2235 mm) in Diameter: 0.034 inch (0.85 mm) with standard spiral-seam construction.
 4. Perforated Inner Ducts: Fabricate with 0.028-inch (0.7-mm) thick sheet metal having 3/32-inch (2.4-mm) diameter perforations, with overall open area of 23 percent.
 5. Maintain concentricity of inner duct to outer shell by mechanical means. Prevent dislocation of insulation by mechanical means.
- B. Fittings: Fabricate double-wall (insulated) fittings with an outer shell and an inner duct.
1. Solid Inner Ducts: Use the following sheet metal thicknesses:
 - a. Ducts 3 to 34 Inches (75 to 865 mm) in Diameter: 0.028 inch (0.7 mm).
 - b. Ducts 35 to 58 Inches (890 to 1475 mm) in Diameter: 0.034 inch (0.85 mm).
 - c. Ducts 60 to 88 Inches (1525 to 2235 mm) in Diameter: 0.040 inch (1.0 mm).
 2. Perforated Inner Ducts: Fabricate with 0.028-inch- (0.7-mm-) thick sheet metal having 3/32-inch- (2.4-mm-) diameter perforations, with overall open area of 23 percent.

2.07 SHOP- AND FIELD-FABRICATED PLENUMS

- A. Description: Provide galvanized steel (unless noted otherwise) air plenums in accordance with Chapter 9 of SMACNA *HVAC Duct Construction Standards – Metal and Flexible*. Air plenums required for this project include:
1. Outdoor air mixing plenums for attachment to the inlet end of air handling units, with connection points for outdoor and return air ducts. Construction shall be 2-inch insulated double wall with solid inner liner; coordinate size, orientation, and layout with Division 23 Section "Modular Packaged Air-Handling Units" and the Drawings.
 2. Outdoor air intake plenums for attachment to exterior outdoor air intake louvers, with connection point(s) for outdoor air duct(s). Construction shall be single wall with exterior insulation; coordinate size, orientation, and layout with Division 08 Section "Louvers and Vents" and the Drawings.
 3. Exhaust air plenums for attachment to exterior exhaust louvers, with connection point(s) for exhaust air duct(s). Construction shall be single wall uninsulated; coordinate size, orientation, and layout with Division 08 Section "Louvers and Vents" and the Drawings.
 4. Other HVAC plenums as indicated on Drawings.
- B. Shop fabricate plenums to greatest extent possible with a minimum of joints and to minimize field fabrication and assembly.

- C. Fabricate plenums with standing seam construction and angle reinforcement. Fabricate close-off sheets from plenum sides, top, and bottom to damper frames. Bolt close-off sheets to frame flanges and housings.
- D. Fabricate plenums with sheet metal walls, top, and bottom panels. Do not use building walls, ceilings or floors as a portion of the plenum boundary, except where expressly shown on Drawings.
- E. Reinforce plenums with galvanized or painted steel angles.
- F. Seal joints as required in Part 3 of this Section.
- G. Fabricate drain pans for air plenums adjacent to exterior louvers with external connection and vented deep-seal trap for drainage piping with a 3/4-inch (20-mm) pipe connection. Fabricate and reinforce drain pans of same material and thickness as housing, 2 inches (50 mm) deep with rolled edges. Solder seams.
- H. Fabricate plenums with reinforced openings for access doors at least 20 inches (500 mm) wide by 48 inches (1200 mm) high and located for access to each item of equipment housed. Each plenum shall have at least one access door; more if shown on Drawings. Access doors shall swing out for negative pressure plenums and in for positive pressure plenums. Refer to Division 23 Section "Duct Accessories" for access doors.
- I. Mount automatic control dampers in air mixing plenums where applicable. Control dampers are supplied as the work of Division 23 Section "Control Systems."

2.08 FACTORY PRE-INSULATED DUCT AND FITTINGS

- A. Contractor's Option: For any ductwork specified to be field-insulated as identified in Division 23 Section "Mechanical Insulation," the contractor shall be granted the option to install factory pre-insulated ductwork in lieu thereof, as specified in this sub-section.
- B. To be considered acceptable, the factory pre-insulated duct system shall meet the same performance requirements specified for each application of traditional ductwork and duct insulation specified herein and in Division 23 Section "Mechanical Insulation," including but not limited to the following characteristics:
 - 1. R-value and thermal conductivity.
 - 2. UL-723 25/50 Flame/Smoke rating.
 - 3. UL-181 Class I air duct compliance.
 - 4. Frictional losses, pressure classes, temperature and velocity limits.
 - 5. Air leakage class and seal class ratings.
 - 6. CFC/HCFC-free and zero Ozone Depletion Potential requirements.
- C. The factory pre-insulated duct system shall include rigid phenolic insulation panels of minimum 29 psi (200 kPa) compressive strength. The rigid phenolic insulation panels shall comprise a closed-cell insulation core, auto-adhesively bonded on both sides to a 1 mil (25 micron) aluminum foil facing, reinforced with a 0.2-inch (5 mm) glass scrim, providing a 0.02-perm water vapor transmission rating.
- D. All other components required for the fabrication of the factory pre-insulated duct system including, but not limited to, the silicone sealant, contact adhesive, aluminum tape, self-adhesive gasket, ductwork reinforcements, closures, connectors and flanges shall be as approved and/or supplied by the manufacturer.
- E. The fabrication and installation of the factory pre-insulated duct system shall be carried out by a fabricator and installer that has successfully completed a specialist training course provided by the manufacturer.
- F. Outdoor duct systems: In addition, the above requirements, the factory pre-insulated duct system shall include the following features where installed outdoors exposed to weather:
 - 1. Thermaaround Metal Clad product with multiple finishes, including Kynar coated steel or aluminum.
 - a. Kynar Exterior Cladding – multiple color option and finish.
 - b. Submit color samples of finishes and options for Owner and Architect approval during shop drawing review. Provide Kynar Finish color sheet with a minimum 26 different color options.
 - c. Protected R-12 insulated value by combining a dual layer of UL 181 Listed InspiralR phenolic ductwork in a round shape to naturally shed water. The entire system including fittings, couplings, and jointing hardware.
 - d. Positive 10-inch WG and Negative 8-inch WG.
 - e. Duct Finishes of Kynar shall be covered in the product's 10-year limited warranty.
- G. The factory pre-insulated duct system is not acceptable for use in the following applications:
 - 1. Kitchen exhaust.
 - 2. Conveyance of any fluid with temperatures in excess of 176°F (80°C).
 - 3. Where stainless steel and/or welded ductwork is specified.

2.09 HANGERS AND SUPPORTS

- A. General: Support all ductwork in accordance with Chapter 5 of SMACNA *HVAC Duct Construction Standards – Metal and Flexible* except where more stringent requirements are specified herein.
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick.
 - 2. Exception: Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.
- C. Hanger Materials: Galvanized sheet steel or threaded steel rod. duct hanger systems consisting of cable or wire are not acceptable; use steel angles, straps, and/or threaded rods.
 - 1. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
 - 2. Hanger Rods for Corrosive Environments: Electro-galvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
 - 3. Strap and Rod Sizes: Comply with SMACNA *HVAC Duct Construction Standards – Metal and Flexible* for steel sheet width and thickness and for steel rod diameters.
 - 4. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.
- D. All supporting material surfaces in direct contact with supported ductwork (or flexible duct, or duct insulation, as applicable) shall be designed to maintain a minimum of one-inch (25 mm) contact width along full length of contact.
- E. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- F. Trapeze and Riser Supports: Steel shapes complying with ASTM A36.
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Stainless-Steel Ducts: Stainless-steel support materials.
 - 3. Supports for Aluminum Ducts: Aluminum support materials unless materials are electrolytically separated from ducts.

2.10 SHOP PRIME PAINT

- A. All aluminum and galvanized steel ductwork that will be installed exposed to view in finished spaces shall be shop-primed to accept field paint.
- B. Coordinate brand and selection with the party responsible for performance of Division 09 Painting Sections.
- C. Coordinate brand and selection with the party responsible for performance of Division 09 Painting Sections.

PART 3 - EXECUTION

3.01 DUCT PRESSURE CLASS SCHEDULE

- A. Static-Pressure Classes: Unless otherwise indicated, construct ducts according to the following:
 - 1. Supply Air Ducts downstream of blower coil units: 2-inch wg (500 Pa).
 - 2. Variable-volume Supply Ducts upstream of VAV boxes: 3-inch wg (750 Pa).
 - 3. Variable-volume Supply Ducts downstream of VAV boxes: 1-inch wg (250 Pa).
 - 4. Outdoor Air Ducts: 4-inch wg (1000 Pa), positive or negative pressure as applicable.
 - 5. Return Ducts: 2-inch wg (500 Pa), positive or negative pressure as applicable.
 - 6. Transfer Ducts: 1/2-inch wg (125 Pa).
 - 7. All Exhaust Ducts located in Mechanical Room and Roof: 6-inch wg (1500 Pa), positive or negative pressure as applicable.
 - 8. Exhaust Ducts located outside of Mechanical Room: 3-inch wg (750 Pa), positive or negative pressure as applicable.
 - 9. Flat Oval Ducts: 10-inch wg (2500 Pa), positive or negative pressure as applicable.
 - 10. Fume Hood Ducts: 10-inch wg (2500 Pa), negative pressure.

3.02 DUCT MATERIAL SCHEDULE

- A. All ducts shall constructed as follows:

1. Laboratory Fume Hood Exhaust Ducts Located in Exposed Spaces: Exhaust ducts originating from any laboratory fume hood shall be Type 316 stainless-steel sheets with No. 4 finish for its entire length of run, with all joints and seams TIG welded. Where laboratory fume hood exhaust ductwork combines with general exhaust ductwork, the downstream ductwork shall be TIG welded stainless steel.
2. Supply and general exhaust air ductwork shall be galvanized steel located inside.
3. All exterior ductwork: Fume hood exhaust, combined fume hood/general exhaust and general exhaust ductwork shall be type 304 stainless steel with No.3 finish for its entire length of run, with all joints and seams welded.
4. All exposed ductwork shall be round or flat oval unless otherwise noted. Exposed supply air ductwork shall be double-wall construction.
5. **Lab M702: All supply air ductwork shall be provided pre-painted. Architect shall select paint type and color during shop drawing reviews. No field painting is permitted.**

3.03 DUCT INSTALLATION

- A. Construct and install ducts according to SMACNA *HVAC Duct Construction Standards – Metal and Flexible* unless otherwise indicated.
- B. Install ducts in maximum practical lengths with fewest possible joints.
- C. Install ducts with fewest possible joints. Install fabricated fittings for changes in directions, size, and shape and for connections.
- D. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12-inches (300 mm), with a minimum of 3 screws in each coupling.
- E. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- F. Install ducts with a clearance of 1-inch (25 mm), plus allowance for insulation thickness.
- G. Duct sizes shown on plans are free area sizes and do not include the thickness of internal duct liner, if any. For double wall duct and/or internally lined ductwork, increase the indicated duct dimensions to account for the liner thickness.
- H. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.
- I. Install duct accessories as required by Division 23 Section "Duct Accessories."
- J. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.
- K. Drawings are diagrammatic in nature. Not necessarily all fittings and offsets are shown. Provide all required fittings and offsets as required by field conditions and coordination with the work of other trades, whether specifically shown or not, for a complete and functional installation.
- L. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.
- M. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- N. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1½ inches (38 mm).
- O. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant. Fire and smoke dampers are specified in Division 23 Section "Duct Accessories." Firestopping materials and installation methods are specified in Division 07 Section "Penetration Firestopping."
- P. Protect duct interiors from the elements and foreign materials throughout construction. Follow SMACNA's "Duct Cleanliness for New Construction." Deliver ducts with shop-applied impervious protective covering over all open ends. Maintain protective end coverings through shipping, storage, and handling to prevent entrance of dirt, debris, and moisture. Elevate stored ducts above grade. As ductwork is installed, remove protective end covering as each successive segment is connected, but with protective end covering maintained over open ends remaining exposed.

3.04 SEAM AND JOINT SEALING SCHEDULE

- A. General: Ducts noted as welded in the Duct Material Schedule above shall be made liquid-tight with all joints and seams full-penetration welded continuously along the entire length of the seam or joint. Otherwise, seal duct seams and joints according to the duct pressure class indicated and as described in

SMACNA *HVAC Duct Construction Standards – Metal and Flexible* except where more stringent requirements are specified herein.

- B. Seal externally insulated ducts before insulation installation.
- C. Seal Class Schedule: Seal Class A and Leakage Class 6 is required for all ducts except as noted below.
 - 1. Spiral lock-seams need not be sealed.
 - 2. Transfer air ducts and transfer air boots need not be sealed.
- D. Rectangular Duct: Sealant materials and methods shall be at contractor's option, chosen from among the products specified in Part 2 of this Section; provided that the above seal class and leakage class schedule is met.
- E. Round or Flat Oval Duct: Transverse joints shall be made with a SMACNA RT-1 interior slip coupling beaded at center, fastened to duct with screws; in addition, apply Two-Part Sealing System continuously around exterior side of joint.
 - 1. Contractor's Option: Furnish prefabricated round duct connection system consisting of self-sealing gasketed fittings. Round duct joints made with this type of fitting do not require the additional sealant specified above, provided that specified seal class is achieved.

3.05 HANGING AND SUPPORTING

- A. Install rigid round, rectangular, and flat-oval metal duct with support systems indicated in SMACNA *HVAC Duct Construction Standards – Metal and Flexible*.
- B. Support horizontal ducts within 24-inches (600 mm) of each elbow and within 48-inches (1200 mm) of each branch intersection.
- C. Support vertical ducts at one- or two-story intervals (i.e., 12 feet (3.66 m) to 24 feet (7.32 m)).
- D. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.
- E. Install concrete inserts before placing concrete.
- F. Install powder-actuated concrete fasteners after concrete is placed and completely cured. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4-inches (100 mm) thick.
- G. Repair any building insulation or building fireproofing materials, whether new or existing, that are removed or scraped away in order to attach hangers and supports, so as to maintain an equivalent insulation or fire rating as existed without said hanger or support attachment.

3.06 CONNECTIONS

- A. Make connections to equipment with flexible connectors according to Division 23 Section "Duct Accessories."
- B. Comply with SMACNA *HVAC Duct Construction Standards – Metal and Flexible* for branch, outlet and inlet, and terminal unit connections.

3.07 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections according to SMACNA's *HVAC Air Duct Leakage Test Manual* and prepare test reports:
 - 1. 25% of all outdoor ducts.
 - 2. 25% of all indoor ducts if design pressure rating is greater than 3-inch w.g.
- B. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
- C. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
- D. Maximum Allowable Leakage: Comply with requirements for Leakage Class 6.
- E. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.

3.08 CLEANING NEW SYSTEMS

- A. Mark position of dampers and air-directional mechanical devices before cleaning, and perform cleaning before air balancing.
- B. Use service openings, as required, for physical and mechanical entry and for inspection.
 - 1. Create other openings to comply with duct standards.
 - 2. Disconnect flexible ducts as needed for cleaning and inspection.

3. Remove and reinstall ceiling sections to gain access during the cleaning process.
- C. Vent vacuuming system to the outside. Include filtration to contain debris removed from HVAC systems, and locate exhaust down wind and away from air intakes and other points of entry into building.
- D. Clean the following metal duct systems by removing surface contaminants and deposits:
 1. Air outlets and inlets (registers, grilles, and diffusers).
 2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
 3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
 4. Coils and related components.
 5. Return-air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.
 6. Supply-air ducts, dampers, actuators, and turning vanes.
- E. Mechanical Cleaning Methodology:
 1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
 2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
 3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
 4. Clean coils and coil drain pans according to ACR 2006. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
- F. Cleanliness Verification:
 1. Visually inspect metal ducts for contaminants.
 2. Where contaminants are discovered, re-clean and reinspect ducts.
- G. Verification of Coil Cleaning: Cleaning must restore coil pressure drop to within 10 percent of pressure drop measured when coil was first installed. If original pressure drop is not known, coil will be considered clean only if it is free of foreign matter and chemical residue, based on thorough visual inspection.

END OF SECTION 23 3113

SECTION 23 3300 – DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Backdraft dampers.
 - 2. Manual volume dampers.
 - 3. Fire dampers, smoke dampers, and fire/smoke dampers.
 - 4. Turning vanes.
 - 5. Duct-mounted access doors.
 - 6. Flexible connectors.
 - 7. Flexible ducts.
 - 8. Duct security bars.
 - 9. Duct accessory hardware.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 23 0100 "Basic Mechanical Requirements," and Section 23 0500 "Basic Mechanical Materials and Methods" all apply to the work of this Section as if fully repeated herein.
- C. The following Sections contain requirements that relate to this Section:
 - 1. Division 23 Section "Control Systems" for actuators associated with automatic control dampers.
 - 2. Division 26 Section "Fire Alarm Systems" for duct-mounted fire detectors.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
- B. Comply with AMCA 500-D testing for damper rating. All manufactured dampers of every type shall bear the AMCA Certified Ratings Program seal for Air Performance, Air Leakage, and Efficiency.

1.5 REFERENCED STANDARDS

- A. Sheet Metal and Air Conditioning Contractors' National Association. *HVAC Duct Construction Standards – Metal and Flexible*. 3rd ed. Chantilly, VA: SMACNA, 2005.

1.6 EXTRA MATERIALS

- A. Furnish extra fusible links that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Furnish quantity equal to 10 percent of amount installed, but not less than two (2).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. HVAC Dampers (all types):
 - a. Air Balance Inc.; a division of Mestek, Inc.
 - b. Greenheck Inc.
 - c. Nailor Industries Inc.
 - d. Pottorff; a division of PCI Industries, Inc.
 - e. Ruskin Company.
 - 2. Remote Damper Operators:
 - a. DuroDyne, Inc.
 - b. Metropolitan Air Technology LLC.
 - c. Pottorff; a division of PCI Industries, Inc.

- d. Ventfabrics, Inc.
- e. Young Regulator Company.
- 3. Turning Vanes:
 - a. Ductmate Industries, Inc.
 - b. DuroDyne Inc.
 - c. Metalaire, Inc.
 - d. Semco Incorporated.
 - e. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- 4. Duct-Mounted Access Doors:
 - a. American Warming and Ventilating; a division of Mestek, Inc.
 - b. Cesco Products; a division of Mestek, Inc.
 - c. Ductmate Industries, Inc.
 - d. Flexmaster U.S.A., Inc.
 - e. Greenheck Fan Corporation.
 - f. McGill AirFlow LLC.
 - g. Nailor Industries Inc.
 - h. Pottorff; a division of PCI Industries, Inc.
 - i. Ventfabrics, Inc.
 - j. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
 - k. Ruskin Company.
- 5. Flexible Connectors:
 - a. Ductmate Industries, Inc.
 - b. Duro Dyne Inc.
 - c. JP Lamborn Co.
 - d. Ventfabrics, Inc.
 - e. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- 6. Flexible Ducts:
 - a. #087 by Atco Rubber Products, Inc.
 - b. Type 8M by Flexmaster USA, Inc.
 - c. "M-KE" by ThermaFlex.

2.2 MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A653/A653M and having G90 (Z275) coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.
- C. Stainless-Steel Sheets: Comply with ASTM A480/A480M, Type 304, and having a No. 2D finish for concealed ducts and No. 4 finish for exposed ducts.
- D. Aluminum Sheets: Comply with ASTM B209 (ASTM B209M), Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- E. Extruded Aluminum: Comply with ASTM B221 (ASTM B221M), Alloy 6063, Temper T6.
- F. Minimum Thickness: All sheet steel used on this project shall be a minimum of 24-gage thickness, and all aluminum sheets shall be a minimum of 0.04-inch thickness, regardless of whether or not SMACNA standards permit thinner gage material.
- G. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- H. Tie Rods: Comply with Articles 2.5 through 2.9, including all accompanying Tables and Figures, of the SMANCA HVAC Duct Construction Standards.

2.3 BACKDRAFT DAMPERS

- A. Description: Gravity balanced, suitable for horizontal or vertical installations. The following requirements apply to conventional backdraft dampers, pressure relief dampers, and barometric relief dampers.
- B. Rated Air Velocity: 3000 fpm (15 m/s).
- C. Rated System Pressure: 2-inch wg (0.5 kPa).
- D. Frame: Match material options below to material of adjacent ductwork. For duct material, refer to Division 23 Section "Metal Ducts."

1. 18-gage or 0.052-inch- (1.3-mm-) thick, galvanized sheet steel, with welded corners and mounting flange.
 2. 16-gage or 0.063-inch- (1.6-mm-) thick extruded aluminum, with welded corners and mounting flange.
 3. 18-gage or 0.052-inch- (1.3-mm-) thick stainless steel, with welded corners and mounting flange.
- E. Blades: Multiple single-piece blades, maximum 6-inch (150-mm) width, 18-gage or 0.050-inch- (1.2-mm) thick aluminum sheet with sealed edges.
- F. Blade Action: Parallel.
- G. Blade Seals: Extruded vinyl or neoprene, mechanically locked into blade edge.
- H. Blade Axles: Nonferrous metal, with diameter of 0.20-inch (5 mm).
- I. Tie Bars and Brackets: Aluminum.
- J. Return Spring: Adjustable tension.
- K. Bearings: Steel ball or synthetic pivot bushings.
- L. Required accessories:
1. Adjustment device to permit setting for varying differential static pressure.
 2. Counterweights and spring-assist kits, if vertical airflow installation.
 3. 90-degree stops.
 4. Duct mounting flange(s).
- M. Sleeve: Minimum 20-gage or 0.040-inch- (1.0-mm) thickness.

2.4 MANUAL VOLUME DAMPERS

- A. Manual volume dampers shall be standard leakage rating, with linkage outside airstream, suitable for horizontal or vertical applications. Volume dampers may be factory-manufactured or contractor-fabricated per SMACNA Fig. 7-4/7-5.
- B. Material: Match material options throughout this subsection to the material of adjacent ductwork. For duct material, refer to Division 23 Section "Metal Ducts."
- C. Frames: Hat-shaped channels with mitered and welded corners, flanges for attaching to walls, and flangeless frames for installing in ducts.
1. Galvanized-steel, 16-gage or 0.064-inch (1.62-mm) minimum thickness, for use in galvanized steel ducts.
 2. Aluminum sheet, 12-gage or 0.100-inch- (2.5-mm-) minimum thickness, for use in aluminum ducts.
 3. Stainless-steel, 16-gage or 0.064-inch (1.62-mm) minimum thickness, for use in stainless steel ducts.
 4. The above requirements may be reduced to 20-gage for round dampers installed in round ducts.
- D. Blades: Multiple-blade; single-blade if duct dimension is 12-inch or less in the direction perpendicular to damper axis. Parallel or opposed-blade design (contractor's choice, unless a specific type is indicated). Stiffen damper blades for stability.
1. Galvanized-steel, 16-gage or 0.064-inch (1.62 mm) thick, for use in galvanized steel ducts.
 2. Roll-Formed Aluminum, 12-gage or 0.10-inch- (2.5-mm-) thick aluminum sheet, for use in aluminum ducts.
 3. Stainless-steel, 16-gage or 0.064-inch (1.62 mm) thick, for use in stainless steel ducts.
 4. The above requirements may be reduced to 20-gage for round dampers installed in round ducts.
- E. Blade Axles: Galvanized steel, aluminum, or stainless steel, as required to match blade material. Dampers shall have axles full length of damper blades, and bearings at both ends of operating shaft.
- F. Bearings: Oil-impregnated bronze, molded synthetic, and stainless-steel sleeve-type are acceptable.
- G. Tie Bars and Brackets: Galvanized steel or aluminum.
- H. Jackshaft:
1. Size: 1-inch (25-mm) diameter.
 2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
 3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.
- I. Damper Hardware:
1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- (2.4-mm-) thick zinc-plated steel, and a 3/4-inch (19-mm) hexagon locking nut.
 2. Include center hole to suit damper operating-rod size.

3. Include elevated platform for insulated duct mounting.

- J. Remote Damper Operators: Cable system designed for remote manual damper adjustment; required accessory for manual volume dampers installed above an inaccessible ceiling. Rotary cable shall have a minimum torque service factor of 200% when installed in accordance with manufacturer-furnished instructions.

1. Tubing: Brass, copper, or aluminum.
2. Cable: Steel.
3. Wall-Box Mounting: Surface.
4. Wall-Box Cover-Plate Material: Stainless steel.

2.5 AUTOMATIC CONTROL DAMPERS

- A. Refer to Section 230900, "Control Systems" for automatic control dampers.

2.6 FIRE DAMPERS

- A. Type: Dynamic; rated and labeled according to UL 555. Label according to UL 555C if used in a rated ceiling application.
- B. Closing rating in ducts up to 4-inch wg (1-kPa) static pressure class and 2000-fpm (10-m/s) velocity.
- C. Fire Rating: 1½ hours.
- D. Frame: SMACNA Type A, B or C as indicated; fabricated with roll-formed, 20-gage galvanized steel; with mitered and interlocking corners. If no indication is given, use Frame Type B for rectangular ducts and Frame Type C for round ducts.
- E. Mounting Orientation: Vertical or horizontal as indicated.
- F. Blades: Roll-formed, interlocking, galvanized sheet steel.
- G. Horizontal Dampers: Include blade lock and stainless-steel negator closure spring.
- H. Single-use Fusible Link: Replaceable, 165°F (74°C) rated, fusible links.
- I. Mounting Sleeve: Factory-supplied, factory or field-installed, galvanized sheet steel sleeve; length as indicated. Include factory-supplied, field-installed two-piece "picture-frame" mounting angles with pre-punched fastener holes.
 1. Direct Grille Mounts: Where specifically indicated, furnish integral factory sleeve/ mounting angle assembly UL-listed for direct grille attachment.
 2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
- J. Multiple-Section Assembly: Where indicated fire damper size exceeds the maximum UL-approved dimensions of the manufacturer's UL-listed product line, provide multiple-section dampers including mullions and other hardware necessary for a UL-approved multi-section fire damper assembly.

2.7 SMOKE DAMPERS

- A. General Requirements: Label according to UL 555S by an NRTL. Low-leakage rating, with linkage outside airstream. Subject to compliance with requirements, an example of an acceptable product is Ruskin Model SD-36.
- B. Leakage Rating: Class II.
- C. Frames: Galvanized sheet steel frame formed into a structural hat channel reinforced at the corners; with mitered and welded corners.
- D. Blades: Multiple-blade type; horizontal airfoil-shaped or triple-v-groove blades with maximum blade width of 6-inches (150 mm).
- E. Blade Axles: ½-inch- (13-mm-) diameter; galvanized steel; square or hex-shape mechanically locked to blade; and blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
- F. Bearings: High impact molded synthetic, or stainless-steel sleeve type, with thrust bearings at each end of every blade. Dampers shall have axles full length of damper blades and bearings at both ends of operating shaft.
- G. Jamb Seals: Stainless steel flexible compression type.
- H. Smoke Detector: Furnished and installed as the work of Division 26.
- I. Mounting Sleeve: Factory-installed, galvanized sheet steel; length to suit wall or floor application.
- J. Damper Motors: Two-position action.
- K. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Motors." Motor size shall be large enough so driven load will not require motor to operate above a 1.0 service factor.

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Temperature Class: -40 to +200°F.
3. Action: Parallel or opposed action as scheduled; opposed if not scheduled.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
5. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
6. Equip with an integral spiral-spring mechanism for fail-safe position as indicated or scheduled. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 150 in. x lbf (17 N x m).
7. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40°F (minus 40°C).
8. Electrical Connection: 24 AC.
9. Test and reset switches, damper-mounted.

- L. Accessories: Auxiliary switches for fan control or position indication.

2.8 COMBINATION FIRE AND SMOKE DAMPERS

- A. General Requirements: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL. Low-leakage rating, with linkage outside airstream. Subject to compliance with requirements, an example of an acceptable product is Ruskin Model FSD-36.
- B. Leakage Rating: Class II.
- C. Closing rating in ducts up to 4-inch wg (1-kPa) static pressure class and minimum 2000-fpm (10-m/s) velocity.
- D. Fire Rating: 1½ hours.
- E. Heat-Responsive Device: Replaceable, 165°F (74°C) rating, fusible link or similar UL-approved bimetal resettable heat-responsive device.
- F. Frames: Galvanized sheet steel frame formed into a structural hat channel reinforced at the corners; with mitered and welded corners.
- G. Blades: Multiple-blade type; horizontal airfoil-shaped or triple-v-groove blades with maximum blade width of 6-inches (150 mm).
- H. Blade Axles: ½-inch- (13-mm-) diameter; galvanized steel; square or hex-shape mechanically locked to blade; and blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
- I. Bearings: High impact molded synthetic, or stainless-steel sleeve type, with thrust bearings at each end of every blade. Dampers shall have axles full length of damper blades and bearings at both ends of operating shaft.
- J. Jamb Seals: Stainless steel flexible compression type.
- K. Damper Motors: Furnished and installed as the work of Division 23 Section "HVAC Instrumentation and Controls."
- L. Smoke Detector: Furnished and installed as the work of Division 26.
- M. Mounting Sleeve: Factory-installed, galvanized sheet steel; length to suit wall or floor application.
- N. Damper Motors: Two-position action.
- O. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Motors."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Temperature Class: -40 to +200°F.
3. Action: Parallel or opposed action as scheduled; opposed if not scheduled.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
5. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
6. Equip with an integral spiral-spring mechanism for fail-safe position as indicated or scheduled. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 150 in. x lbf (17 N x m).
7. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40°F (minus 40°C).
8. Electrical Connection: 24 AC.
9. Test and reset switches, damper-mounted.

- P. Accessories: Auxiliary switches for fan control or position indication.

2.9 TURNING VANES

- A. All turning vanes, where required, shall be single-thickness type, 2-inch (50-mm) radius, 1½-inch (38-mm) spacing, at least 24-gauge thickness, and curved through an arc matching the change of direction (i.e., a vane curved through 90-degrees for a 90-degree elbow). Construct of material matching that of the adjacent duct (i.e., galvanized steel turning vanes in a galvanized steel duct, stainless steel turning vanes in a stainless steel duct, etc.).
- B. Where two or more changes of direction occur with less than four duct widths (measured in the plane of the change of direction) between each elbow, each turning vane shall also include a straight trailing edge extension of 1-inch (25 mm). At contractor's option, all turning vanes may include this straight trailing edge extension even if not required.
- C. Include vane rails or runners for attachment of vane blades to duct.
- D. Either contractor-fabricated or factory-manufactured turning vanes meeting these specifications will be acceptable.

2.10 DUCT-MOUNTED ACCESS DOORS

- A. Duct-Mounted Access Doors: Factory-manufactured doors, airtight and suitable for duct pressure class.
- B. Door: Double wall, rectangular, galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
- C. Insulation: 1-inch (25-mm-) thick, fibrous-glass or polystyrene-foam board.
- D. Hinges and Latches: 1-by-1-inch (25-by-25-mm) butt or piano hinge and cam latches.
- E. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.
- F. Number of Hinges and Locks: Two hinges, or continuous piano hinge, and two sash locks.
- G. Size: 18 by 10-inches (460 by 250 mm) unless noted otherwise

2.11 FLEXIBLE CONNECTORS

- A. Materials: Flame-retardant or noncombustible fabrics.
- B. Coatings and Adhesives: Comply with UL 181, Class 1.
- C. Metal-Edged Connectors: Factory fabricated with a fabric strip 5¾-inches (146 mm) wide attached to 2 strips of 2¾-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized sheet steel or 0.032-inch- (0.8-mm-) thick aluminum sheets. Provide metal compatible with connected ducts.
- D. Fabric: Glass fabric double-coated with neoprene or polychloroprene. Fabric layers shall be shielded with metal on both sides at the seam, attached with a mechanical metal-to-fabric bond.
 - 1. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
 - 2. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
 - 3. Service Temperature: Minus 40 to plus 200°F (Minus 40 to plus 93°C).
 - 4. Insulated Service: Flexible ductwork connections shall be constructed of two layers of fabric as specified above, encapsulating 1-inch nominal thickness of R-4.2 fiberglass insulation. Required if the adjacent ductwork is specified to be insulated or internally lined.
 - 5. Outdoor Service: Glass fabric shall be double-coated with weatherproof, synthetic rubber resistant to UV rays and ozone. Required if installed outdoors.
- E. Thrust Limits: As specified in Division 23 Section "Mechanical Vibration Isolation."

2.12 FLEXIBLE DUCTS

- A. General: Comply with UL 181, Class 1. Factory-fabricated, insulated, round duct, with an outer jacket enclosing glass-fiber insulation around a continuous inner liner.
 - 1. Reinforcement: Galvanized steel wire helix encapsulated in inner liner.
 - 2. Outer Jacket: Polyethylene vapor-barrier film.
 - 3. Inner Liner: CPE film, acoustically transparent to mid-range sound energy.
- B. Required Pressure Ratings:
 - 1. Sizes 12-inch and smaller: At least 8-inch wg positive and 1-inch wg negative.
 - 2. Sizes larger than 12-inch: At least 4-inch wg positive and ½-inch wg negative.
 - 3. Burst Rating: 2.5 times working pressure rating above.
- C. Velocity Rating: 4000 fpm.
- D. Temperature Rating: -20°F to +250°F.
- E. Thermal Rating: Minimum R-4.2 thermal resistance.

- F. Flexible Duct Connector Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 through 18-inches, to suit duct size.
- G. Provide flexible ducts with Flexflow elbow by Thermaflex for connections to air devices.

2.13 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards – Metal and Flexible."
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts.
 - 1. Locate dampers at least two duct diameters from fittings and as far away as possible from outlets.
 - 2. Install steel volume dampers in steel ducts.
 - 3. Install aluminum volume dampers in aluminum ducts.
 - 4. Install stainless steel volume dampers in stainless steel ducts.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire dampers, smoke dampers, and fire/smoke dampers according to UL listing.
- H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. Adjacent to and close enough to fire dampers, to reset or reinstall fusible links.
 - 2. Downstream of in-duct coils.
 - 3. Elsewhere as indicated.
- I. Install access doors with swing against duct static pressure.
- J. Label access doors according to Division 23 Section "Basic Mechanical Materials and Methods" to indicate the purpose of access door.
- K. Install flexible connectors to connect ducts to equipment using metal-edged connections or flanges.
- L. For fans developing static pressures of 5-inch wg (1250 Pa) and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- M. Connect air devices to ducts with flexible duct clamped or strapped in place.
- N. Connect air devices to ducts directly or with a maximum 72-inch (1800-mm) length of flexible duct clamped or strapped in place. Do not connect flexible duct to any exhaust system.
- O. Install flexible ducts in accordance with the following:
 - 1. Turn radius of flexible duct at duct centerline shall not exceed one times nominal duct diameter.
 - 2. At least one support shall be installed for every run of flexible duct that is 60-inches (1500 mm) long or longer; more if needed to comply with next paragraph.
 - 3. Support flexible duct so that it does not contact nor rest upon light fixtures, sprinkler and other piping, ceilings and ceiling hanger wires, electrical conduits and cable tray, and similar items.
 - 4. All supporting material surfaces in direct contact with supported flexible duct shall maintain a minimum of one-inch in contact width along full length of contact.
 - 5. Comply with Figures 3-10 and 3-11 in SMACNA's *HVAC Duct Construction Standards – Metal and Flexible*. 3rd ed. except where more stringent details are given on the Drawings.
 - 6. Comply with Specifications 3.5, 3.6, and 3.7, paragraphs S3.19 through S3.40, of SMACNA's *HVAC Duct Construction Standards – Metal and Flexible*. 3rd ed., except where more stringent requirements are specified herein.
- P. Install duct test holes where required for testing and balancing purposes.
- Q. Flexible ductwork shall not be used on ducted return or exhaust systems.

- R. No flexible ductwork shall be upstream of VAV boxes.
- S. Flexible connections shall be provided at connections to all moving equipment.
- T. For locations where static pressure will be over 2.0 in. wc., dampers shall be opposed blade with adjustable quadrant and locking device with position indicator.
- U. If duct static is greater than 2.0 in.wc., a manual balance dampers shall be installed upstream of the VAV box at the branch take-off for pressure reduction.

3.2 FIELD QUALITY CONTROL

- A. Operate dampers to verify full range of movement.
- B. Inspect locations of access doors and verify that purpose of access door can be performed.
- C. Operate fire dampers to verify full range of movement and verify that proper heat-response device is installed.
- D. Inspect turning vanes for proper and secure installation.

END OF SECTION 23 3300

SECTION 23 3419 – LABORATORY MECHANICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Air volume control products associated with laboratory fume hoods and rooms.
 - 2. Fan Filter Units (FFU)

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 23 0100 "Basic Mechanical Requirements" and Section 23 0500 "Basic Mechanical Materials and Methods" all apply to the work of this Section as if fully repeated herein.
- C. The following Sections contain requirements that relate to this Section.
 - 1. Division 23 Section "Metal Ductwork" contains requirements that relate to this Section.
 - 2. Division 23 Section "Duct Accessories" for duct flexible connectors.
 - 3. Division 23 Section "Control Systems" for control devices.

1.3 PERFORMANCE REQUIREMENTS

- A. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Sections.
- B. Product Data including rated capacities of each unit, weights (shipping, installed, and operating), furnished specialties, accessories, and the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound power ratings.
 - 3. Material gages and finishes, including color charts.
 - 4. Dampers, including housings, linkages, and operators.
 - 5. Manufacturer's standard color chart.
- C. Shop Drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.
- D. Provide data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings that include air flow, static pressure, and sound power levels for each of the second through sixth octave bands in dBA.
- E. Certifications: Certify that air capacities, pressure drops, and selection procedures meet or exceed specified requirements.
- F. Manufacturer's Installation Instructions: Indicate support and hanging details, installation instructions, recommendations, and service clearance requirements.
- G. Wiring diagrams detailing wiring for power and control systems and differentiating clearly between manufacturer-installed and field-installed wiring.
- H. Maintenance data for air-handling units to include in the operation and maintenance manual specified in Division 01 and in Division 23 Section "Basic Mechanical Requirements."
- I. Operation and Maintenance Data: For fan filter units to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Documented aspiration tests shall have been performed in conjunction with the fan performance test.
- B. Sound testing shall be in accordance with AMCA 300.
- C. Electrical Component Standard: Provide components that comply with NFPA 70 and that are listed and labeled by UL where available.

- D. Listing and Labeling: Provide electrically operated fixtures specified in this Section that are listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) as defined in OSHA Regulation 1910.7.
- E. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- F. ASHRAE Standard 55 – Thermal Environmental Conditions for Human Occupancy; 2013.
- G. ASHRAE Standard 70 – Method of Testing the Performance of Air Outlets and Air Inlets; 2012.
- H. CSA Standard Z317.2-10 – Special Requirements for Heating, Ventilation, and Air-conditioning (HVAC) Systems in Health Care Facilities; 2010.
- I. IEST-RP-CC002.3 – Recommended Practice for Unidirectional-Flow of Clean Air Devices; 20019.
- J. UL Standard 507 – Standard for electric fans; 1999.
- K. UL Standard 900 – Standard for Air Filter Units; 2015.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Lift and support units with the manufacturer's designated lifting or supporting points.
- B. Coordinate delivery date to site with installing Contractor.

1.7 PROJECT CONDITIONS

- A. Field Measurements: Verify dimensions by field measurements. Verify clearances.

1.8 COORDINATION AND SCHEDULING

- A. Coordinate the installation of equipment supports.

1.9 EXTRA MATERIALS

- 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 for each modular air-handling unit.
- B. Filters: Furnish one (1) additional set for each fan filter unit.
- C. Gaskets: Furnish one (1) additional complete set for each fan filter unit.

1.10 DEFINITIONS

- A. ADR refers to the Aircuity Air Data Router
- B. AWP refers to Aircuity's Architectural Wall probe
- C. BAS refers to the Building Automation System. (Similar terms are: EMS, Energy Management System; BMS, Building Management System; FMS, Facility Management System; or ATC, Automatic Temperature Control.)
- D. DPB refers to Aircuity's Duct Probe
- E. FMC refers to the Facility Monitoring System Contractor. The FMC is the Contractor responsible for the implementation of this Section of the Specifications
- F. FMS refers to the hardware, software and other components comprising the Facility Monitoring System as herein described.
- G. I/O refers to Input/Output. Thus, "I/O device" means "Input/Output device".

1.11 WARRANTY

- A. Provide 18-month manufacturer warranty from the date of shipment for all fan filter units.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Volume Boxes: Subject to compliance with requirements, provide laboratory air volume control products by one of the following:
 - 1. Accutrol, LLC.
 - 2. Phoenix Controls Corporation.
- B. Fan Filter Units: Subject to compliance with requirements, provide fan filter unit products by one of the following:
 - 1. Price Industries; E.H. Price Co.
 - 2. Terra Universal Incorporated

2.2 LABORATORY AIRFLOW CONTROL SYSTEM

- A. All laboratory airflow controls shall be provided to allow all supply air, general exhaust and fume hood exhaust to operate in a variable flow configuration. All electric actuators shall only be high speed on all control valves.
- B. A laboratory airflow control system shall be furnished and installed to control the airflow into and out of laboratory rooms and reheat coils within those rooms. The exhaust flow rate of a laboratory fume hood shall be precisely controlled to maintain the indicated minimum and maximum airflows into the fume hood. The fume hood control shall be of variable air volume type. The laboratory control system shall vary the amount of makeup/supply air into the room to operate the laboratories at the lowest possible airflow rates necessary to maintain laboratory pressurization in relation to adjacent spaces (positive or negative) as indicated on the Drawings. The plans and specifications for the laboratory airflow control system are based on systems and equipment manufactured by Phoenix Controls Corporation.
- C. Laboratory Airflow Control System Warranty: Warranty shall commence upon the date of shipment and extend for a period of thirty-six (36) months, whereupon any defects in materials or laboratory airflow control system performance shall be repaired by the supplier at no cost to the Owner.
- D. Each laboratory space shall have a dedicated laboratory airflow control system.
- E. The laboratory airflow control system shall employ individual average face velocity controllers that directly measure the area of the fume hood sash opening and proportionally control the hood's exhaust airflow to maintain a constant face velocity.
- F. The hood exhaust airflow control device shall respond to the fume hood sash opening by achieving 90% of its commanded value within one second of the sash reaching 90% of its final position (with no more than 5% overshoot/undershoot) of required airflow. Rate of sash movement shall be between 1.0 to 1.5 feet per second.
- G. The hood exhaust airflow control device shall be automatically switched between in-use and standby levels based on operator presence immediately in front of the hood. A presence and motion sensor shall activate the switching. The airflow control device shall achieve the required in-use command value in less than one second from moment of detection with no more than a 5% overshoot or undershoot.
- H. The laboratory airflow control system shall maintain specific airflow (+/- 5% of signal within one second of a change in duct static pressure) regardless of the magnitude of the pressure change 0.6-inch to 3.0-inch w.c. for medium pressure valves), airflow change, or quantity of airflow control devices on the manifold.
- I. The laboratory airflow control system shall maintain a specific airflow (+/- 5% of signal) with a minimum 16 to 1 turndown to ensure accurate pressurization at low airflow and guarantee the maximum system diversity and energy efficiency.
- J. Airflow Control Valves (ACV):
 - 1. All controllers shall be medium pressure valves.
 - 2. The airflow control valve shall be a venturi air valve.
 - 3. The airflow control device shall be pressure independent over its specified differential static pressure operating range. An integral pressure independent assembly shall respond and maintain specific airflow within one second of a change in duct static pressure, irrespective of the magnitude of pressure and/or flow change or quantity of airflow controllers on a manifolded system.
 - 4. The airflow control device shall maintain accuracy within $\pm 5\%$ of signal over an airflow turndown range of no less than 16 to 1. No minimum entrance or exit duct diameters shall be required to ensure accuracy and/or pressure independence.
 - 5. The airflow control device shall be constructed of one of the following two types, Class A or Class B as described below.

6. Class A – The airflow control device for non-corrosive airstreams such as supply and general exhaust shall be constructed of 16 gauge aluminum. The device's shaft and shaft support brackets shall be made of 316 stainless steel. The pivot arm and internal mounting link shall be made of aluminum. The pressure independent springs shall be spring grade stainless steel. All shaft bearing surfaces shall be made of a Teflon, or polyester, or PPS (polyphenylene sulfide) composite.
 7. Sound attenuating devices used in conjunction with general exhaust or supply airflow control devices shall be constructed using 24 gauge galvanized steel or other suitable material used in standard duct construction. No sound absorptive materials of any kind shall be used.
 8. Class B – The airflow control device for corrosive airstreams such as fume hoods shall have a baked-on corrosion resistant phenolic coating. The device's shaft shall be made of 316 stainless steel with a Teflon coating. The shaft support brackets shall be made of 316 stainless steel. The pivot arm and internal mounting link shall be made of 316 or 303 stainless steel. The pressure independent springs shall be a spring grade stainless steel. The internal nuts, bolts and rivets shall be stainless steel. All shaft bearing surfaces shall be made of Teflon or PPS (polyphenylene sulfide) composite.
 9. An electric actuator shall be factory mounted to the valve. Loss of control power shall cause normally open valves to fail to maximum position, and normally closed valves to fail to minimum position.
 - a. All actuators shall be high-speed electric.
 10. Certification: Each airflow control device shall be factory calibrated to the job specific airflows as detailed on the plans and specifications using NIST traceable air stations and instrumentation having a combined accuracy of at least $\pm 1\%$ of signal over the entire range of measurement. Electronic airflow control devices shall be further calibrated and their accuracy verified to $\pm 5\%$ of signal at a minimum of eight different airflows across the full operating range of the device.
 11. All airflow control devices shall be individually marked with device specific, factory calibration data. As a minimum, it should include; tag number, serial number, model number, eight point characterization information (for electronic devices), and quality control inspection numbers. All information shall be stored by the manufacturer for use with as-built documentation.
 12. The airflow control device shall use closed loop control to linearly regulate airflow based on a 0 to 10 volt control signal. The device shall generate a 0 to 10 volt feedback signal that is linearly proportional to its airflow.
- K. Laboratory Control Unit:
1. A laboratory control unit shall control the supply and/or general exhaust airflow control devices to maintain proper room pressurization polarity (positive or negative). Each individual laboratory shall have a dedicated laboratory control unit.
 2. The control unit shall be electronic. The inputs shall accept linear feedback signals from fume hood, and supply airflow control devices. The output signals shall control supply, or general exhaust with signals that are linearly proportional to the desired supply or exhaust airflows.
 3. The control unit shall maintain a constant design offset between the sum of the room's total exhaust and make-up/supply airflows. This offset shall be field adjustable and represents the volume of air that will enter (or exit) the room from the corridor or adjacent spaces.
 4. The control unit shall provide linear signals that are proportional to all airflow sources, sash sensors, and flow alarms. The signals shall be available for hard-wired connection to the Energy Management and Control System (EMCS), or through an integrated control unit that interfaces directly into the EMCS. The EMCS is specified in Division 23 Section "Control Systems."
 5. The laboratory control unit may be either panel or valve mounted.
 6. Refer to sequence of operation on the drawings for the necessary points to be monitored by the EMCS.
 7. Each laboratory shall have a dedicated 120 VAC line connection to power the laboratory's airflow control system supply power. Coordinate with Division 26 for power requirements.
- L. Interface to Building Management Systems
1. The LACS network shall have the capability of digitally interfacing with the BMS. The required software interface drivers shall be developed and housed in a dedicated interface device furnished by the LACS supplier.
 2. All room-level points shall be available to the BMS for monitoring or trending as shown in Table 1.

Table 1: Typical Integration Points List

Point Description	Read/Write	Point Description	Read/Write
<i>Valve-Level (per Valve)</i>		<i>Temperature Control (per Zone)</i>	
Flow Set Point	Read Only	Space Temperature	Read Only
Flow Feedback	Read Only	Avg Space Temperature	Read Only
Jam Alarm	Read Only	Discharge Air Temperature	Read Only
Flow Alarm	Read Only	Duct Temperature	Read Only
User Definable Inputs/Outputs	Read/Write	Temperature Set Points (9)	Read/Write
User Definable Alarm Points	Read Only	Effective Temperature Set Point	Read Only
<i>Zone Balance Control (per Zone)</i>		Offset Lever Enable	Read/Write
Occupied Min Ventilation Rate	Read/Write	Offset Lever Percent of Range	Read/Write
Unoccupied Min Ventilation Rate	Read/Write	Cooling Demand	Read Only
Offset	Read Only	Heating Demand	Read Only
Offset Set Point	Read/Write	Heat Delivered (BTU)	Read Only
MAV Command & Feedback	Read Only	Auxiliary Temp Control Demand	Read Only
GEX Command & Feedback	Read Only		
Return Command & Feedback	Read Only		
Total Zone Supply Flow	Read Only		
Total Zone Exhaust Flow	Read Only		
Total Hood Flow Feedback	Read Only		
Diversity Alarm	Read Only		
<i>Fume Hood Control (per Hood Valve)</i>			
Face Velocity	Read Only		
Face Velocity Set Point	Read Only		
Sash Opening Percentage	Read Only		
User Status	Read Only		
Hood Override Alarm	Read Only		
Sash Height Alarm	Read Only		
Broken Sash Cable Alarm	Read Only		
Sash Switch Status	Read Only		
<i>Emergency Mode (per Zone)</i>			
Emergency Mode Override	Read/Write		
Emergency Mode State	Read Only		
<i>Occupancy Control (per Zone)</i>			
Occupancy Override	Read/Write		
Occupancy State	Read Only		

3. LACS critical environment integration shall support distributed network architecture from LON FTT-10 bus to a dedicated BACnet MS/TP segment, using single or multiple IP addresses. Backbone communication protocol must be field selectable/upgradable.
4. Communication between devices in a room or zone will operate independent of building level communications maintaining integrity of the airflow. LACS Building level communication, or loss of, will not disrupt the communication between devices in a room or zone.
5. LACS critical environment integration shall provide an easy means to access room level device health status at a room-by-room or building wide level via web page. The system health pages shall provide information to assist in diagnostics for:
 - a. Online/Offline status for the room level integration appliance.
 - b. Runtime information such as heap memory usage and CPU usage.

- c. Communication channel online/offline and configuration data.
 - d. Device level online/offline information.
 - e. Device level alarm information.
 - f. Device level Configuration errors.
 - 6. LACS critical environment integration shall provide an easy means to access a Test and Balance function tool at a room-by-room or building wide level via web page. Test and balance functions should include:
 - a. Setting the devices in the room to various conditions in order to read airflow.
 - b. Manually override the outputs for testing purposes.
 - c. Adjust airflow to meet field acceptance tests.
 - d. Output a report for airflow performance test.
 - 7. LACS critical environment integration must be able to support SQL database for long term data storage.
 - 8. LACS critical environment integration shall provide optional software to manage local backup and restore, entire site device management, building wide test and balance functions, building wide diagnostic tools, and building wide configuration tools. Software shall be field upgradable to support graphical dashboard displays.
- M. Neutralizer: Provide a neutralizer to be used in conjunction with general exhaust and supply air valves. See plans for locations.
- 1. The attenuator shall consist of resonator chambers that are tuned to the output frequencies of the air valve, providing a reduction in sound power levels over the entire sound spectrum.
 - 2. Construction: 24 gauge galvanized steel.
 - 3. Field provided square to round transition is required for single valve units.
 - 4. The pressure drop across the device shall be less than 0.1-inch w.c.

2.3 FAN FILTER UNITS

- A. General:
- 1. The fan filter unit shall be supplied to provide unidirectional supply air at controlled discharge velocities. The units shall include a High Efficiency Particulate Air (HEPA).
 - 2. Modules sizes, electrical characteristics, efficiencies, capacities, and options shall be as scheduled on drawings.
- B. Performance:
- 1. The unit shall provide filtered air tested at an average velocity of 90 fpm (+/- 15 fpm) measured 12 inches from the face of the unit in accordance with IEST-RP-CC0022.2.
 - 2. The room sound level shall be less than 55 dBA when measured at 30 inches from the filter face at 90 fpm average face velocity in accordance with IEST-RP-CC0022.2.
 - 3. The unit is to be factory sealed and tested to assure leakage is consistent with the filter.
- C. Construction:
- 1. Plenum material shall be:
 - a. Aluminum.
 - 2. Face material shall be:
 - a. Expanded metal grille with powder-coat paint finish
 - 3. Plenum shall be walkable up to 250 lbs.
 - 4. The diffuser plenum shall feature four (4) eyebolts at each plenum corner for securing the unit to structural supports above the ceiling.
 - 5. The 51% free-area perforated distribution plate shall be secured to the face using quarter-turn fasteners with anti-slip, snap-in retainers and stainless steel retainer cables for ease of installation and removal.
 - 6. Inlet: standard round or optional rectangular collar for non-ducted applications.
 - 7. Eye bolts for hanging shall be mounted on the top four (4) corners of the plenum and capable of each supporting 75 lbs.
- D. Filters:
- 1. The filter shall be framed in extruded aluminum with an integral cavity filled with a urethane gel to provide a leak-tight seal between the filter frame and the border.
 - 2. Filter type shall be:
 - 3. High Efficiency Particulate Air (HEPA) filter shall provide 99.997% efficiency on .30 µm particulate, with an initial pressure drop of 0.45" wg at 100 fpm.
 - 4. Filter shall be UL 900 classified.
 - 5. Filter pack depth shall be 2.5".

6. Filter media shall be borosilicate micro-fiberglass.
7. Filter shall be:
 - a. Bench top removable and replaceable, mounted in an extruded aluminum frame with an upstream gasket. Bench top replaceable filters shall be supplied with a room-side accessible static pressure port in an extruded aluminum center divider.
- E. Plenum Finish shall be:
 1. All aluminum components shall have B12 White baked-on powder coat finish.
 - a. The paint finish must demonstrate no degradation when tested in accordance with ASTM D1308 (covered and spot immersion) and ASTM D4752 (MEK double rub) paint durability tests.
 - b. The paint film thickness shall be a minimum of 2.0 mils.
 - c. The finish shall have a hardness of 2H.
 - d. The finish shall withstand a minimum salt spray exposure of 1000 hours.
 - e. The finish shall have an impact resistance of 80 in-lb.
- F. Face and frame finish shall be:
 1. All aluminum components shall have White B12 Standard baked-on powder coat finish.
 - a. The paint finish must demonstrate no degradation when tested in accordance with ASTM D1308 (covered and spot immersion) and ASTM D4752 (MEK double rub) paint durability tests.
 - b. The paint film thickness shall be a minimum of 2.0 mils.
 - c. The finish shall have a hardness of 2H.
 - d. The finish shall withstand a minimum salt spray exposure of 1000 hours.
 - e. The finish shall have an impact resistance of 80 in-lb.
- G. Fan:
 1. The centrifugal type fan shall be supplied with rubber mounts to isolate the motor/blower assembly from the diffuser plenum. Fans are to be of metal construction with a direct drive:
 - a. Forward curved impeller
 - b. Backward curved impeller
 2. Plastic construction shall not be acceptable.
- H. Electrical Systems:
 1. Single point power connection.
- I. Fan Motor:
 1. The fan motor shall be:
 - a. Electrically Commutated Motor (ECM):
 - 1) Constant Torque Program
 - a) A constant torque program shall be provided to allow the ECM to vary the airflow with fluctuations in both upstream static pressure and filter pressure drop.
 - b) The constant torque program shall prevent unexpected motor operation or motor shutdown due to upstream static pressure fluctuations.
 - c) The constant torque program shall be used for ducted applications where fluctuations in upstream pressure may occur.
 - 2) Constant Flow Program
 - a) A constant flow program shall be provided to allow the ECM to compensate for fluctuations in both upstream static pressure and filter pressure drop, providing constant airflow.
 - b) The constant flow program shall be used for non-ducted applications where the inlet static pressure is zero or slightly negative.
 - c) Fan motor shaft directly connected to fan and isolated from casing to prevent transmission of vibration.
 2. Fan motor shall have internal thermal and overload protection.
 3. Fan motor shaft shall be directly connected to the fan impeller, and isolated from casing to prevent transmission of vibration.
 4. Fan motor shall be supplied with a motor speed controller (select one):
 - a. ECM standard speed controller
 - 1) The ECM speed controller shall operate on 24 VAC supply voltage.
 - 2) The ECM speed controller shall have dual outputs to control up to two motors simultaneously.

- 3) The ECM speed controller shall be supplied with a BAS interface to accept 2-10 VDC signal for variable speed remote control, as well as be able to remotely shut off via BAS signal.
 - 4) The ECM speed controller shall be supplied as a wall mounted kit, shipped loose for field installation.
- J. Options:
1. Filter replacement style:
 2. Bench Top replaceable filter
- K. Pre-filter:
1. Non-ducted units:
 - a. Unit shall be provided with 25-30% MERV 4 washable pre-filter.
 2. Ducted units:
 - a. Unit shall be provided with 25-30% MERV 4 washable pre-filter with side access filter housing.
- L. Disconnect Switch: A factory supplied disconnect switch shall be provided for disconnection of power to the terminal block.
- M. Power cord:
1. An eight foot (2.4 m) power cord shall be supplied for use with a 115 V power supply.
- N. Motor/blower access:
1. Room side access
- O. Filter status indicator shall be communicated by:
1. LED Indicator light:
 - a. The LED indicator light shall be visible from the occupied area to determine the filter loading status without opening the diffuser.
 - b. The LED light shall turn from green to yellow when the pressure drop across the filter exceeds the specified limit.
 - c. The LED kit shall be provided with a switch, factory pre-calibrated for 150% of initial clean filter pressure drop.
 - d. The LED kit shall operate on a 24 VAC power supply, provided by others.
- P. Motor status shall be communicated by:
1. Motor status LED:
 - a. The LED indicator light shall be visible from the occupied area to determine the motor operating status without opening the diffuser.
 - b. The motor LED shall be green to indicate normal motor operation, and that the unit static pressure is above 0.2" wg.
 - c. The motor LED shall turn from green to red when the motor is not in operation, and when the unit static pressure is below 0.2" wg.
 2. Motor status BAS signal:
 - a. The factory- calibrated motor BAS signal shall close a dry contact to generate a BAS signal when the motor is not operating.
 - b. Unit shall be field wired to the terminal block according to manufacturer's instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of laboratory air volume control products, and other system components. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install fan filter units according to manufacturer's written instructions.
- B. Install units with clearances for services and maintenance.
- C. See drawings for the size and location of fan filter unit inlets.
- D. Support components individually from structure in accordance with SMACNA (SRM).
- E. Do not support components from ductwork.
- F. Laboratory Airflow Control System Installation:
1. Install the sash sensors, interface boxes, and fume hood monitor on the fume hood under initial supervision of the laboratory airflow control system supplier. Reel-type sash sensors and their

stainless steel cables shall be hidden from view. Bar-type sash sensors shall be affixed to the individual sash panels. Sash interface boxes with interface cards shall be mounted in an accessible location.

2. Install the laboratory control unit (if panel-mounted) and wall-mounted power supply (as required) in an accessible location in the designated laboratory room.
3. Terminate and connect all cables as required. In addition, integrated laboratory control unit connectors shall be furnished by this contractor.
4. Install all airflow control devices in the ductwork and connect all airflow control valve linkages.
5. Connect Neutralizer with sheet metal screws. Seal any gaps with duct sealant. Assemble multiple units according manufacturer's recommendation. Install attenuator with airflow direction arrow pointing in the direction of airflow. The attenuator shall be installed between the valve and the first air device (diffuser, grille, or register).
6. Perform all controls work in complete and strict accordance with Division 23 Section "Control Systems."

3.3 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts and duct accessories.
- B. Electrical: Conform to applicable requirements in Division 26 Sections. Connect wiring and ground equipment according to Division 26 Sections.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise the field assembly of components and installation, including duct and electrical connections, and to report results in writing.

3.5 ADJUSTING & CLEANING

- A. Adjust damper linkages for proper damper operation.
- B. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.
- C. Clean fan interiors to remove foreign materials and construction debris. Vacuum clean fan wheel and cabinet.
- D. Ensure supply air to the fan filter units by performing pitot traverse on the main supply duct.

3.6 COMMISSIONING

- A. Perform the following operations and checks before startup of exhaust fans:
 1. Verify that shipping, blocking, and bracing are removed.
 2. Verify that unit is secure on mountings and supporting devices, and that connections for ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnects.
 3. Perform cleaning and adjusting specified in this Section.
 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearings operation. Reconnect fan drive system.
 5. Verify lubrication for bearings and other moving parts.
 6. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in the fully open position.
- B. Starting procedures for fans are as follows:
 1. Energize motor; verify proper operation of motor, drive system, and fan wheel.
 2. Adjust fan to indicated RPM.
 3. Measure and record motor voltage and amperage.
 4. Replace fan and motor as required to achieve design conditions.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
- B. Review data in the operation and maintenance manuals. Refer to Division 01.
- C. Schedule training with Owner, through Architect, with at least 7 days' advance notice.
- D. Demonstrate operation of products specified in this Section. Conduct walking tour of the Project. Briefly identify location and describe function, operation, and maintenance of each product.

- E. Laboratory Airflow Control System Start-Up: System start-up shall be provided by a factory authorized representative of the laboratory airflow control system manufacturer. Start-up shall include calibrating the fume hood monitor and any combination sash sensing equipment as required. Start-up shall also provide electronic verification of airflow (fume hood exhaust, supply, and general exhaust) and system programming.
- F. The laboratory airflow control system supplier shall furnish a minimum of four hours of owner training, by factory trained and certified personnel. The training will provide an overview of the job specific airflow control components, verification of initial fume hood monitor calibration, general procedures for verifying airflows of air valves, and general troubleshooting procedures. Operation and Maintenance manuals, including as-built wiring diagrams and component lists shall be provided for each training attendee.

END OF SECTION 23 3419

SECTION 23 3423 – FANS AND VENTILATORS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:

1. Utility set fans.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 23 0100 "Basic Mechanical Requirements," and Section 23 0500 "Basic Mechanical Materials and Methods" all apply to the work of this Section as if fully repeated herein.
- C. The following Sections contain requirements that relate to this Section:
1. Division 23 Section "Motors" specifies the motors required for use with fans.
 2. Division 23 Section "Mechanical Vibration Isolation" for vibration hangers and supports.
 3. Division 23 Section "Duct Accessories" for duct flexible connectors.
 4. Division 23 Section "HVAC Instrumentation and Controls" for control devices.
 5. Division 26 Section "Variable Frequency Drives" for variable speed motor controllers.
- D. Stand-alone fans are specified herein. Refer to other Division 23 Sections for fans which are an integral part of packaged equipment.

1.3 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base fan-performance ratings on sea level, unless noted otherwise.
- B. Operating Limits: Classify according to AMCA 99-16.
- C. Fan Unit Schedule: The following information is specified in an equipment schedule on the Drawings.
1. Fan performance data including capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
 2. Fan arrangement including wheel configuration, inlet and discharge configurations, and required accessories.

1.4 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Sections.
- B. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
1. Certified fan performance curves with system operating conditions indicated.
 2. Certified fan sound-power ratings.
 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 4. Material thickness and finishes, including color charts.
 5. Dampers, including housings, linkages, and operators.
 6. Roof curbs.
 7. Fan speed controllers.
- C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- D. Wiring Diagrams: Detail wiring for power and control systems, and differentiating clearly between manufacturer-installed and field-installed wiring.
- E. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
1. Roof framing and support members relative to duct penetrations.
 2. Ceiling suspension assembly members.
 3. Size and location of initial access modules for acoustical tile.
 4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
- F. Field quality-control test reports.

- G. Operation and Maintenance Data: For fans and ventilators to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: 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. AMCA Compliance: All fans and ventilators shall bear the AMCA Certified Ratings Program seal for Air and Sound Performance. In addition, compliance with either one or both of the following two subparagraphs is required.
1. All fans and ventilators shall bear the AMCA Certified Ratings Program seal for Fan Efficiency Grade (FEG).
 2. All fans and ventilators shall bear the AMCA Certified Ratings Program seal for Fan Energy Index (FEI).
- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- D. UL Standard: Power ventilators shall comply with UL 705.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.
- B. Disassemble and reassemble units, if required for moving to final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS APPLICABLE TO ALL FANS AND VENTILATORS

- A. Manufacturers: Subject to compliance with requirements, provide fans and ventilators by one of the following:
1. Acme Engineering & Mfg. Corp.
 2. Carnes Company.
 3. Greenheck Inc.
 4. Hartzell Fan, Inc.
 5. JenCo Fan.
 6. PennBarry, division of Air System Components.
 7. Twin City Fan Company.
- B. Single Source: All fans of any given type shall all be provided by the same manufacturer.
- C. Motors: Refer to Division 23 Section "Motors" for general requirements for factory-installed motors, whose requirements apply to the work of this Section as if fully repeated herein.
1. Motor Construction: NEMA MG 1, general purpose, continuous duty, Design B.
 2. Enclosure Type: Open drip-proof, where satisfactorily housed; guarded drip-proof, where subject to contact by employees, maintenance staff, or building occupants.
 3. Motor Sizes: Minimum size as indicated, but larger if necessary so driven load will not require motor to operate in service factor range at design point, and larger if necessary so driven load will not require motor to operate beyond the service factor at any point on the fan curve.
 4. Provide inverter-ready or inverter-duty motors with shaft grounding rings as specified in Division 23 Section "Motors" everywhere variable speed drives are indicated.
- D. Disconnect Switch: Provide a factory-installed and pre-wired non-fused disconnect switch for all fans and ventilators, unless specifically noted otherwise.
- E. Factory Finishes: Provide as follows.
1. Sheet Metal Parts: Prime coat before final assembly.
 2. Exterior Surfaces: Baked-enamel finish coat after assembly. Finish shall pass a 1,000-hour salt spray test conducted per ASTM B117 method.
 3. Aluminum Parts: No finish required.
- F. Sound-Power Level Ratings: Comply with AMCA 301-14 *Methods for Calculating Fan Sound Ratings from Laboratory Test Data*. Factory test fans according to AMCA 300-14 *Reverberant Room Method for Sound Testing of Fans*.
- G. Wheel Balance: Factory-balance all fan wheels in accordance with AMCA Standard 204-05 (R2012) *Balance Quality and Vibration Levels for Fans*.

- H. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to ASHRAE Standard 51-2016 (ANSI/AMCA Standard 210-2016) *Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating*.
- I. Fan Capacities and Characteristics: As scheduled on the Drawings.

2.2 UTILITY SET FANS

- A. Description: Direct-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and accessories.
 - Base fan performance at standard conditions (density 0.075 Lb/ft³).
- A. Fans selected shall be capable of accommodating static pressure and flow variations of +/-15% of scheduled values.
- B. Each belt drive fan shall be in AMCA arrangement 9, 9H or 10 according to drawings. Each direct drive fan shall be AMCA arrangement 4 or 8 according to drawings.
- C. Fans are to be equipped with lifting points.
- D. All FRP surfaces are ground smooth prior to top coating to ensure there are no exposed glass fibers. All hardware located within the airstream will be made of stainless steel and encapsulated in FRP. Finish color shall be gray. No exposed metal parts in the airstream will be allowed.

2.1 FAN HOUSING AND OUTLET

- A. Fan housing is to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence.
- B. The housings on all fan sizes shall conform to PS 15-96 FRP construction standards. They will be made using fire retardant vinylester resins. All interior surfaces of the housing exposed to the airstream will be resin rich and contain no more than 20% of "C" grade glass veil. The exterior surfaces of the housing will be resin rich and use a paraffinated resin stabilized against ultraviolet degradation. No exposed metal parts will be allowed within the airstream. The finish color will be gray.
- C. Housing and bearing support shall be constructed of welded structural steel members to prevent vibration and rigidly support the shaft and bearings bearings and coated with enamel or epoxy to prevent corrosion.
- D. For belt drive fans, an OSHA compliant belt guard and shaft guard shall be included to completely cover the sheaves and belt(s).
- E. Housings for sizes 6 through 25 are fully rotatable.

2.2 FAN WHEEL

- A. The fan wheel shall be of the non-overloading single width backward curved centrifugal type. Wheels shall be statically and dynamically balanced to balance grade G6.3 per ANSI S2.19.
- B. Fan wheel shall be manufactured from a FRP encapsulated steel hub and backplate with FRP blades strapped in for added strength. The wheels will be made using a non-fire retardant resin chosen for strength characteristics. Finish color shall be gray.
- C. The wheel and fan inlet shall be carefully matched and shall have precise running tolerances for maximum performance and operating efficiency.
- D. The shaft to impeller connection is EXTERNAL to the gas stream with the encapsulated hub extending out of the housing using a taper-Lock bushing for the physical connection. Neither the shaft nor the shaft-impeller connection is exposed to the gas stream. The impeller hub is encapsulated with mat and resin.

2.3 FAN MOTORS AND DRIVE

- A. Motors shall meet or exceed EPACT (Energy Policy ACT) efficiencies. Motors to be NEMA T-frame, 1800 or 3600 RPM, Open Drip Proof (ODP) or Totally Enclosed Fan Cooled (TEFC) with a 1.15 service factor.
- B. Drive belts and sheaves shall be sized for 150% of the fan operating brake horsepower, and shall be readily and easily accessible for service, if required.
- C. Fan shaft to be turned and polished steel that is sized so the first critical speed is at least 25% over the maximum operating speed for each pressure class.
- D. Fan shaft bearings shall be Air Handling Quality, bearings shall be heavy-duty grease lubricated, self-aligning or roller pillow block type.
- E. Air Handling Quality bearings to be designed with low swivel torque to allow the outer race of the bearing to pivot or swivel within the cast pillow block. Bearings shall be 100% tested for noise and vibration by the manufacturer. Bearings shall be 100% tested to insure the inner race diameter is within tolerance to prevent vibration.
- F. Bearings shall be fixed to the fan shaft using concentric mounting locking collars, which reduce vibration, increase service life, and improve serviceability. Bearings that use set screws shall not be allowed.
- G. Bearings shall have Zerk fittings to allow for lubrication.

- B. Shaft Bearings: Pre-lubricated and sealed, self-aligning, pillow-block-type ball bearings with ABMA 9, L₁₀ of 40,000 hours.
- C. Roof Equipment Support: Pate Model ES-5b; galvanized steel; mitered and welded corners; 1½-inch- (40-mm-) thick, rigid, fiberglass insulation adhered to inside walls; 1½-inch (40-mm) wood nailer; and galvanized steel counterflashing.
 - 1. Configuration: Built-in raised cant and mounting flange.
 - 2. Overall Dimensions: 5½-inch wide by 13½-inch high; length to suit fan mountings.
 - 3. Pitch Mounting: Manufacture curb for roof slope, so that fan is installed level.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements of installation tolerances and other conditions affecting performance of the fans and ventilators. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install fans and ventilators level and plumb, and in accordance with manufacturer's written instructions.
- B. Install fans and ventilators using vibration isolators. Vibration-control devices are specified in Division 23 Section "Mechanical Vibration Isolation."
- C. Install fans and ventilators using vibration isolators. Vibration-control devices are specified in Part 2 of this Section.
- D. See Division 23 Section "Basic Mechanical Materials and Methods" for additional anchorage and concrete base requirements.
- E. Install units with clearances for service and maintenance.
- F. Label units according to requirements specified in Division 23 Section "Basic Mechanical Materials and Methods."

3.3 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Duct Accessories."
- B. Coordinate ducts, pipes, conduit, and other work adjacent to fans and ventilators to allow service and maintenance clearance in accordance with manufacturer's installation instructions.
- C. Connect wiring and ground equipment according to Division 26 Sections.

3.4 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Lubricate bearings.
- D. Testing, Adjusting and Balancing is the work of Division 23 Section "Testing, Adjusting, and Balancing", which shall include adjustment of fan to indicated rpm. After initial testing and balancing, the work of this Section shall include pulley/sheave replacement to meet operating conditions indicated. Remove, size, select, and install the proper pulley/sheave sizes, to match specified performance.
 - 1. Exception: Pulley/sheave replacement is not required for fans whose speed is controlled by a variable frequency drive, provided that specified performance can be met with speed controller at or below 100% output.
 - 2. Exception: Pulley/sheave replacement is not required where pulley/sheave is adjustable in pitch.

3.5 CLEANING

- A. On completion of installation, internally clean fans according to manufacturer's written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.
- B. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Provide the services of a factory-authorized field service representative to inspect the installation of fans, including duct and electrical connections, and to report the results in

writing. The field service representative shall perform, or shall witness the contractor's performance of, the following field tests and inspections and prepare test reports.

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.
10. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
11. Shut unit down and reconnect automatic temperature-control operators.
12. Remove and replace malfunctioning units and retest as specified above.
13. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fans and ventilators. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
- B. Review data in maintenance manuals. Refer to Division 01.
- C. Schedule training with Owner, through Architect, with at least seven days' advance notice.
- D. Demonstrate operation of fans and ventilators. Conduct walking tour of the Project. Briefly identify location and describe function, operation, and maintenance of each fan and ventilator.

END OF SECTION 23 3423

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SECTION 23 3600 – AIR TERMINAL UNITS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Shutoff single-duct air terminal units.
 - 2. Exhaust single-duct air terminal units.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 23 0100 "Basic Mechanical Requirements," and Section 23 0500 "Basic Mechanical Materials and Methods" all apply to the work of this Section as if fully repeated herein.
- C. Related sections include Division 23 Section "Control Systems" for control devices and installation associated with air terminals.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated, include rated capacities; furnished specialties and accessories; shipping, installed, and operating weights; and sound-power ratings for each model indicated. Detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection. Include a schedule showing unique model designation, room location, model number, size, and accessories furnished.
- B. Shop Drawings: For air terminal units. Include plans, elevations, sections, details, and attachments to other work. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection. Hangers and supports, including methods for duct and building attachment and vibration isolation.
- C. Verify compliance with each third-party test or rating Standard referenced in the "Quality Assurance" subsection below.
- D. Coordination Drawings: Refer to Division 23 Section "Basic Mechanical Requirements."
- E. Field quality-control reports.
- F. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01, include instructions for resetting minimum and maximum air volumes and for adjusting software set points.

1.04 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air terminal units and are based on the specific system indicated. Refer to Division 23 Section "Basic Mechanical Requirements."
- B. NFPA Compliance: Install air terminal units according to NFPA 90A-2015 *Standard for the Installation of Air Conditioning and Ventilating Systems*.
- C. AHRI Certification: Only air terminals that are certified under the AHRI Standard 880-2017 Certification Program and carry the AHRI Seal will be accepted.
- D. Controls: Test and rate air terminal unit controls in accordance with ANSI/ASHRAE 195-2013 *Method of Test for Rating Air Terminal Unit Controls*. This standard specifies instrumentation, facilities, test installation methods, and procedures for determining the accuracy and stability of airflow control systems for pressure independent terminal units at various airflow setpoints for variable-air-volume and constant-volume air-moving systems.
- E. Control sequences shall be in complete and strict accordance with ASHRAE Guideline 36-2018 *High Performance Sequences of Operation for HVAC Systems*.

1.05 COORDINATION

- A. Coordinate layout and installation of air terminal units and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide Air Terminal Units by one of the following:
1. Air System Components Inc. (Titus, Krueger, and Tuttle & Bailey brands).
 2. Carnes Co., Inc.
 3. Environmental Technologies, Inc.
 4. Hart & Cooley, Inc.
 5. Greenheck Inc.
 6. Price Industries Inc.
 7. Trane Technologies plc.

2.02 AIR TERMINAL UNITS, GENERAL

- A. Configuration: Pressure independent terminal unit as scheduled; including volume-damper assembly inside unit casing with control components located inside a protective metal shroud. Unit sizes, capacities, maximum and minimum airflows, maximum noise ratings, and maximum air pressure drops shall be as scheduled on the Drawings.
- B. Casing: Minimum 22-gage galvanized steel or 0.032-inch (0.8-mm) aluminum.
1. Air Inlets: Beaded round stub connection of length at least 2-inches beyond airflow sensor taps for inlet duct attachment.
 2. Air Outlets: Rectangular S-slip and drive connections.
 3. Access: Removable panels [or access door] for access to damper, heating coil, and other parts requiring service, adjustment, or maintenance; with airtight gasket.
- C. Oversize Casing Sizing Criteria: For any and all Air Terminal Units specified or scheduled to include a hydronic heating coil, the Air Terminal Unit casing size and hydronic coil physical size shall both be increased one standard size increment without increasing the duty-sized inlet diameter.
1. For example, a terminal whose duty calls for 8-inch nominal size shall be furnished as a 10-inch nominal size terminal but with an 8-inch inlet, airflow sensor, and damper.
 2. It is not acceptable to increase the entire terminal size to satisfy the above criteria. For example, it is not acceptable to furnish to a complete 10-inch terminal size where duty calls for 8-inch inlet, airflow sensor, and damper; product must be a 10-inch nominal terminal with an 8-inch inlet.
 3. The above oversizing criteria is not required for cooling-only terminals; nor terminals with an electric-resistance heating coil.
 4. Subject to compliance with requirements, examples of acceptable products include Titus Model DESVE and Price Model HSG.
- D. Volume Damper: Minimum 22-gage galvanized steel with peripheral edge gasket and self-lubricating bearings. Include a mechanical hard stop to prevent over-stroking. Include permanent markings on damper shaft to indicate damper position by simple visual inspection.
- E. Maximum allowable damper leakage is given below, when tested according to AHRI 880-2017, based on 4-inch wg (1000-Pa) differential static pressure (inlet to outlet) and 2500 fpm (12.7 m/s) air velocity at nominal box inlet diameter.
1. 3% for nominal size 4-inch (100 mm).
 2. 2% for nominal sizes 5-inch (125 mm) through 7-inch (175 mm).
 3. 1% for nominal sizes 8-inch (200 mm) and larger.
- F. Airflow Sensor: Multipoint, multi-axis inlet velocity sensor with center-averaging feature, factory installed and connected to the controller with UL-listed fire-retardant pneumatic tubing. Single axis sensor is not acceptable for inlet diameters 6-inch and larger. The sensor shall output an amplified differential pressure signal that is at least 2.3 times the equivalent velocity pressure signal obtained from a conventional pitot tube. Balancing taps and airflow calibration charts shall be provided for field airflow measurements.

2.03 EXHAUST-APPLICATION AIR TERMINAL UNITS

- A. General: All specifications above for "Air Terminal Units, General" apply to air terminal units used in return or exhaust applications in which the primary air-movement fan is downstream of, not upstream of, the terminal unit; *except* as noted below:
1. Casing does not require thermal insulation unless needed to achieve specified sound performance.
 2. Both inlet and outlet dimensions shall be round (not rectangular).

3. Type 304 or 316 stainless steel duct assembly is required for applications in which the adjoining duct is constructed of stainless steel. See Division 23 Section "Metal Ducts" and/or the Drawings for notation of which ducts shall be stainless steel.
4. Manufacturer shall conspicuously mark intended direction of airflow on the exterior of the terminal unit.

2.04 UNIT INSULATION

- A. Fibrous-Glass Liner: All Air Terminal Units of all types shall include factory-installed internal liner. Comply with NFPA 90A and UL 181.
 1. Materials: Rigid, rectangular, fibrous-glass duct board; factory molded and faced on airstream side with fire-resistive, reinforced, foil-scrim-kraft barrier. 4-pound density, 475 flexural rigidity, standard duty. All cut edges or exposed fibers not encapsulated by the foil scrim surface shall be sealed from the airstream by mechanically bonded metal edge strips or nosings.
 2. Alternative Materials: Subject to compliance with other requirements specified herein, including but not limited to acoustic requirements, manufacturer's standard internal fiberglass liner will be accepted if entirely isolated from the airstream by an inner solid liner constructed of 26-gage galvanized sheet metal or 0.032-inch aluminum sheet.
 3. Thickness: ½-inch (13 mm) minimum; thicker if required to meet specified or scheduled values for thermal and/or acoustic performance.
 4. Thermal Conductivity (k-Value): 0.26 at 75°F (0.037 at 24°C) mean temperature per ASTM C518.
 5. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E84.
 6. Liner Adhesive: Comply with NFPA 90A and with ASTM C916.

2.05 INTEGRAL ACCESSORIES

- A. Integral Sound Attenuator Section: 0.034-inch (0.85-mm) steel or 0.032-inch (0.8-mm) aluminum sheet metal, with internal acoustic lining matching the specification "Unit Insulation" Article elsewhere in this Section. Cover liner with perforated 26-gage galvanized sheet metal or aluminum of equivalent thickness.

2.06 INTEGRAL HYDRONIC HEATING COILS

- A. Casing: Minimum 20-gauge galvanized steel, factory-installed, with flanged connection for outlet ductwork. See "Air Terminal Units, General" subsection above for sizing criteria.
- B. Pressure Rating: Leak test to 300 psi air under water; minimum burst pressure of 2000 psi.
- C. Performance Ratings: As scheduled on Drawings. Coils shall be designed, tested and rated according to AHRI Standard 410-2001 *Forced-Circulation Air-Cooling and Air-Heating Coils*.
- D. Tube Construction: Copper, ½-inch O.D. with 0.016-inch minimum wall.
- E. Fin Construction: Aluminum, 0.006-inch minimum thickness, not more than 12 per inch, mechanically-bonded to tubes.
- F. Piping Connections: Male solder header. Coil connections shall be on the side of the unit indicated on the Drawings.

2.07 AIR TERMINAL UNIT CONTROLS

- A. DDC Controls: Factory-furnish and factory-install air terminal unit manufacturer's airflow sensor and unit damper without actuator. The DDC controller, damper actuator, room temperature sensor, and 24-volt power supply are the work of Division 23 Section "Control Systems." The manufacturer of the air terminal unit shall receive shipment of actuator and controller, and factory-install same as the work of this Section.
 1. Coordination: The air terminal unit manufacturer shall advise the party responsible for the work of Division 23 Section "Control Systems" as to the particular characteristics of the unit's damper, shaft, and airflow sensor. The party responsible for the work of Division 23 Section "Control Systems" shall furnish data sheets on all components to be mounted, indicating component dimensions, mounting hardware and instructions, and wiring and piping diagrams for each application. The air terminal unit manufacturer shall check and verify all wiring and tubing connections prior to final shipment to the jobsite.

2.08 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electro-galvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

- C. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- D. Trapeze and Riser Supports: Steel shapes and plates for units with steel casings; aluminum for units with aluminum casings.

2.09 SOURCE QUALITY CONTROL

- A. Identification: Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and AHRI certification seal.
- B. Verification of Performance: Test and rate air terminal units according to AHRI 880-2017 *Standard for Performance Rating of Air Terminals*.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install air terminal units level and plumb, according to manufacturer's written instructions, rough-in drawings, original design, and referenced standards. Maintain sufficient clearance for normal service and maintenance.
- B. Protect all openings of air terminal units with filters or temporary covers throughout project storage, handling, and placement, to keep clean the interiors of air terminal units.
- C. Terminal units shall be continuously insulated with thermal insulation and vapor barrier, in unbroken path from inlet duct through to outlet duct, so that no bare metal surfaces are left uninsulated. Field-insulate any portions of terminal unit if not factory-insulated, including but not limited to heating coil casing and duct inlet collar. Field insulation and vapor barrier are specified in Division 23 Section "Mechanical Insulation."
- D. After completing system installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes. Vacuum clean the interior of air terminals if the openings were not protected during construction.

3.02 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible," Chapter 4, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches (100 mm) thick.
 - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches (100 mm) thick.
- C. Hangers Exposed to View: Threaded rod and angle or channel supports.
- D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.03 MECHANICAL CONNECTIONS

- A. Ductwork: Connect ductwork to air terminals according to Division 23 ductwork Sections and Details on Drawings.
- B. Hot Water Piping: Connect heating coils. Install piping adjacent to air terminal units to allow service and maintenance. Piping installation requirements are specified Division 23 Section "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

3.04 ELECTRICAL CONNECTIONS

- A. Power, signal, and control wiring for cooling-only Air Terminal Units and/or Air Terminal Units with hydronic heating coils is the work of Division 23 Section "Control Systems."

3.05 IDENTIFICATION

- A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Division 23 Section "Basic Mechanical Materials and Methods" for equipment labels and warning signs and labels.

3.06 FIELD QUALITY CONTROL

- A. Complete installation and startup checks according to manufacturer's written instructions, and perform the following field tests and inspections:
 - 1. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
 - 2. Verify that controls and control enclosure are accessible.
 - 3. Verify that control connections are complete.
 - 4. Verify that nameplate and identification tag are visible.
 - 5. Verify that controls respond to inputs as specified.
 - 6. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
 - 7. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Remove and replace malfunctioning units and retest as specified above.
- C. Engage a factory-authorized service representative to train Owner's maintenance personnel in proper adjustment, operation, troubleshooting, and maintenance of air terminal units. Refer to Division 01 for requirements.

END OF SECTION 23 3600

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SECTION 23 3713 – DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes ceiling- and wall-mounted diffusers, registers, and grilles.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 23 0100 "Basic Mechanical Requirements," and Section 23 0500 "Basic Mechanical Materials and Methods" all apply to the work of this Section as if fully repeated herein.
- C. The following Sections contain requirements that relate to this Section:
 - 1. Division 08 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents installed in exterior walls, whether or not they are connected to ducts.
 - 2. Division 23 Section "Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.
 - 3. Division 23 Section "Testing, Adjusting, and Balancing" for balancing diffusers, registers and grilles.

1.3 DEFINITIONS

- A. Diffuser: Circular, square, or rectangular air distribution outlet, generally located in the ceiling and comprised of deflecting members discharging supply air in various directions and planes and arranged to promote mixing of primary air with secondary room air.
- B. Grille: A louvered or perforated covering for an opening in an air passage, which can be located in a sidewall, ceiling, or floor.
- C. Register: A combination grille and damper assembly over an air opening.

1.4 SUBMITTALS

- A. Product Data: For each product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate Drawing designation, room location, quantity, model number, size, and accessories furnished.
- B. Sample for Initial Selection: Submit manufacturer's color charts showing the full range of colors available for diffusers, registers, and grilles with factory-applied color finishes; where required or indicated by notes on Schedule.

1.5 QUALITY ASSURANCE

- A. Testing: Test and publish performance according to ANSI/ASHRAE Standard 70-2006 *Method of Testing the Performance of Air Outlets and Air Inlets*.
- B. NFPA Compliance: Install diffusers, registers, and grilles according to NFPA 90A-2015 *Standard for the Installation of Air-Conditioning and Ventilating Systems*. Where located less than 84 inches above finish floor, diffusers, registers and grilles shall be designed to prohibit passage of a ½-inch sphere.
- C. Single-Source: Unless noted otherwise, a single manufacturer shall furnish all diffusers, registers, and grilles.

PART 2 - PRODUCTS

2.1 COMMON REQUIREMENTS, ALL UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Air System Components Inc. (Titus, Krueger, and Tuttle & Bailey brands).
 - 2. Carnes Co.
 - 3. Hart & Cooley, Inc.
 - 4. Greenheck Inc.
 - 5. Nailor Industries, Inc.
 - 6. Price Industries.
- B. Diffusers, registers, and grilles are scheduled on Drawings. All model numbers, finish designations, border types, and accessory designations are based one manufacturer identified therein. Products by other

manufacturers listed above may be furnished, but must be equal in all respects to the device identified, including but not limited to NC, pressure, and cfm ratings.

- C. Diffusers, Registers, and Grilles Finish: Acrylic baked enamel paint, pencil hardness HB to H, color as scheduled. The finish shall pass a 250-hour ASTM 870 Water Immersion Test, a 100-hour ASTM D117 Corrosive Environments Salt Spray Test, and a 50 inch-pound ASTM D2794 Reverse Impact Cracking Test.
- D. Integral Balancing Damper: Where dampers are scheduled as an integral part of diffusers and grilles (registers), provide multi-blade gang-operated opposed-blade type, radial-style if used with round ducts; 24 gage galvanized steel, except that aluminum dampers shall be used with aluminum diffusers and registers. Integral dampers shall be operable from the room side of the diffuser or register without special tools.
- E. Diffusers, Registers, and Grilles Mounting: Provide border frame mounting type as scheduled. If not scheduled, provide border frame mounting type compatible with ceiling or wall type indicated on Architectural Drawings. Distinguish between flush flat-tee lay-in ceilings, drop-face lay-in ceilings, and the narrow-tee or screw-slot lay-in ceilings by providing a border type specifically designed for each as applicable; a generic standard lay-in border frame will not be acceptable for multiple lay-in ceiling types.

2.2 PRODUCT SPECIFICATIONS

- A. Square Plaque Ceiling Diffuser: 22-gage steel (use 0.040-inch aluminum where scheduled) face panel that captures a secondary panel of equal material and thickness. The face panel shall be removable via four hanger brackets. The exposed surface of the face panel shall be smooth, flat, and free of visible fasteners. The face panel shall project not more than ¼-inch below the outer border of the diffuser back pan. The back of the face panel shall have a rolled edge, shaped for horizontal discharge. Face panel shall be no smaller than 18-inch by 18-inch for diffusers nominally 24-inch by 24-inch. Face panel shall be no smaller than 9-inch by 9-inch for diffusers nominally 12-inch by 12-inch. The back pan shall be one-piece die-stamped and include an integrally drawn inlet (welded-in inlets and corner joints are not acceptable). Include a diffuser neck of minimum 1¼-inch depth for connection and attachment of round or rectangular (as scheduled) duct.
 - 1. Include round damper constructed of heavy gauge steel. Damper shall be operable from the face of the diffuser.
 - 2. Include directional blow clips to restrict the discharge air in certain directions.
 - 3. Include molded insulation blanket of R-6, foil-backed. Provide an additional 1-inch gap around the neck to install insulated flex duct.
 - 4. Where an aluminum or stainless steel grille or diffuser is indicated by Schedule or note, the entire product shall be constructed of aluminum or stainless steel as applicable, including but not limited to face plate, pattern controllers, border, back pan, neck, collar, etc.
- B. Standard-Performance Grille: Adjustable double-deflection supply grilles, single fixed deflection return grilles, of sizes and performance as scheduled. Blades shall be 24-gage steel; supply grille blades shall be individually adjustable and held in place without rattling or slip by tension wire or metal friction pivots. Frame shall be roll-formed 24-gage steel or with 1-inch minimum flange and full penetration welds at the corners. Exposed screw holes shall be countersunk for flush finish surface.
- C. Corrosion-Resistant Grille: Adjustable double-deflection supply grilles, single fixed deflection return grilles, of sizes and performance as scheduled. Blades shall be 24-gage Type 304 stainless steel; supply grille blades shall be individually adjustable and held in place without rattling or slip by tension wire or metal friction pivots. Frame shall be roll-formed 24-gage Type 304 stainless steel or with 1-inch minimum flange and full penetration welds at the corners. Exposed screw holes shall be countersunk for flush finish surface.
- D. Plenum Slot Diffuser: Extruded aluminum slot diffuser with length, number, and width of slots as scheduled, and integral 24-gage insulated galvanized steel plenum with a factory-drawn side inlet and minimum 1-inch collar for connection and attachment of flexible duct. Provide aerodynamic steel deflector blades for supply diffusers, capable of full 180-degree pattern adjustment, dampering, and shut-off. No screws, clips, or other mounting hardware shall be visible from the room served.
- E. Specialty Diffuser System for Rig Rooms: System of perimeter linear air curtain slot diffusers and interior vertical laminar flow diffusers.
 - 1. Perimeter linear diffusers shall be constructed for a 12-inch wide plenum. The diffuser shall be a two-slot design with provision for blanking off one slot. Include pressure induction plates for automatic airflow balance. Slots shall include field-adjustable blades with a minimum adjustment range of 5 to 15 degrees. Diffuser shall be constructed of 20-gage Type 304 stainless steel (use 0.046-inch aluminum where scheduled).

2. An outer frame and factory-manufactured plenum shall be installed on the diffuser. The diffuser shall have quarter-turn fasteners for removal from plenum. The plenum shall have all outer corners radiused with a 3/4-inch minimum radius. All welded joints shall be ground smooth. Plenums must be connected at all joints using bolt-together flanges. Include a neck of minimum 1 1/4-inch depth for connection and attachment of round duct.
 3. The corners of the perimeter system shall be interconnected using transition elbows with removable face covers. Corner transitions shall not reduce the cross-sectional area of the plenum. Removable face covers shall expose the entire corner section for cleaning and inspection.
 4. Interior vertical laminar flow diffusers shall be constructed using a maximum 6-inch tall backpan with integral hanger tabs for securing the unit to structure above. Each unit shall include an integral internal baffle for even air distribution across the face of the diffuser. The diffuser face shall be constructed of 22-gage Type 304 stainless steel (use 0.040-inch aluminum where scheduled) and shall be perforated with 3/32-inch diameter holes on 1/4-inch centers in a 60-degree staggered pattern for 13% nominal free area. The face plate shall be secured in place by quarter-turn fasteners for removal, with retainer cable to prevent face plate from falling to the floor. Include removable center plug for adjusting the damper. Include a neck of minimum 1 1/4-inch depth for connection and attachment of round duct.
 5. Where an aluminum or stainless steel grille or diffuser is indicated by Schedule or note, the entire product shall be constructed of aluminum or stainless steel as applicable, including but not limited to face plate, pattern controllers, border, back pan, neck, collar, etc.
- F. Other grilles, registers and diffusers not specified above may be specified on the Drawings or by virtue of make and model number on the Schedules.

2.3 FIELD-PROVIDED ACCESSORIES

- A. Other accessories may be required by virtue of notations on the Schedule or as detailed on the Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Install diffusers, registers, and grilles level and plumb.
- C. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- D. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.
- E. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.
- F. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Replace diffusers, registers, and grilles that have damaged finishes.

END OF SECTION 23 3713

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SECTION 23 7313 – MODULAR PACKAGED AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes packaged modular air-handling units with coils for indoor installations as further described herein.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. The following Sections contain requirements that relate to this Section:
 - 1. Division 23 Section "Motors."
 - 2. Division 26 Section "Variable Frequency Drives" for motor controllers utilized to vary the speed of the fan motors in response to a temperature control signal.
 - 3. Division 23 Section "Duct Accessories" for dampers used as an integral part of factory-packaged air-handling units specified in this Section.
 - 4. Division 23 Section "Control Systems" for temperature controls, wiring, devices, components, and actuators for dampers furnished under this Section.

1.3 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Sections.
- B. Product Data: For each type of blower coil unit indicated. Include the following:
 - 1. Certified fan-performance curves with system operating conditions indicated.
 - 2. Certified fan-sound power ratings.
 - 3. Certified coil-performance ratings with system operating conditions indicated.
 - 4. Motor ratings, electrical characteristics, and motor and fan accessories.
 - 5. Material gages and finishes.
 - 6. Filters with performance characteristics.
 - 7. Dampers, including housings, linkages, and operators.
 - 8. Leakage class rating as determined via ASHRAE Standard 111.
 - 9. Product data for all specified accessories.
 - 10. **All fans shall be selected with an allowance of 1.5 inches internal static pressure for dirty filters.**
- C. Shop Drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.
- D. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
- E. Coordination Drawings: Submit with Shop Drawings. Show mechanical-room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.
- F. Source quality-control reports.
- G. Field quality-control reports.
- H. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.
- I. Warranty: Air-handling units shall have a minimum of 3-year warranty on all parts and accessories.
- J. **Blower coil units will be brought into the building through existing doors and corridors, up elevator. Any component that requires disassembly to move into the building, Contractor shall have manufacturer representative available to monitor disassemble and resemble to maintain manufacturer's warranty and scheduled performance. Components of the unit shall not be cut to bring into the building.**

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain blower coil units through one source from a single manufacturer.

- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of factory-packaged air-handling units and are based on the specific system and model indicated. Refer to Division 23 Section "Basic Mechanical Requirements" for guidelines concerning the use of other systems or models.
- C. NFPA Compliance: Factory-packaged air-handling units and components shall be designed, fabricated, and installed in compliance with NFPA 90A *Installation of Air Conditioning and Ventilating Systems*.
- D. AHRI Certification: Air-handling unit and component product lines shall be factory-tested according to the applicable portions of AHRI 430 and shall be listed and bear the label of the Air-Conditioning Heating and Refrigeration Institute (AHRI).
- E. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2016, Section 6 – "Heating, Ventilating, and Air-Conditioning."
- F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2016, Section 5 – "Systems and Equipment" and Section 7 – "Construction and Startup."
- G. Fan Performance Ratings: Rate according to ASHRAE Standard 51-2016 (ANSI/AMCA Standard 210-2016) *Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating*. In addition, all airfoil fans shall comply with AMCA standard 99-2408-69 and 99-2401-82 and shall bear the AMCA Seal.
- H. Sound Power Level Ratings: Rate according to AMCA 301 *Methods for Calculating Fan Sound Ratings from Laboratory Test Data* and AMCA 300 *Reverberant Room Method for Sound Testing of Fans*. Fans shall bear AMCA-certified sound ratings seal.
- I. Sound Power Level Ratings: Rate according to AHRI 260-2017 *Sound Rating of Ducted Air Moving and Conditioning Equipment*.
- J. Air-Handling Unit Casing Leakage Ratings: Rate and publish leakage ratings for air-handling unit product line in accordance with ASHRAE Standard 111-2008 *Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems*. All units furnished for this project shall comply with ASHRAE 111-2008 Class 6 leakage rating.
- K. Air Coils: Certify capacities, pressure drops, and selection procedures in accordance with AHRI 410.
- L. UL and NEMA Compliance: Provide motors required as part of air-handling units that are listed and labeled by UL and comply with applicable NEMA standards.
- M. Comply with NFPA 70 for components and installation.
- N. Listing and Labeling: Provide electrically operated components specified in this Section that are listed and labeled. The terms "Listed" and "Labeled" are defined in the National Electrical Code, Article 100.

1.5 COORDINATION

- A. Coordinate delivery date to site with installing Contractor.
- B. Coordination: Coordinate layout and installation of blower coil units with piping and ductwork and with other installations.

1.6 DELIVERY, STORAGE, AND HANDLING:

- A. Comply with ASHRAE 62, Section 7 (practices to be followed during construction and startup). Protect equipment from moisture by appropriate in-transit and on-site procedures.
- B. Provide shrink-wrap around unpainted units. The membrane shall cover entire air handling unit during shipping and storage. Cover equipment, regardless of size or shape. Tarping is not acceptable.
- C. Shrink-wrap equipment, including electrical components, for protection against rain, snow, wind, dirt, sun fading, road salt/chemicals, rust and corrosion. Keep equipment clean and dry.
- D. Deliver air-handling unit as a factory-assembled module with shipping splits only as necessary and with protective crating and covering.
- E. Store per air handling unit Manufacturer's written recommendations. Store blower coil unit indoors in a warm, clean, dry place where units will be protected from weather, construction traffic, dirt, dust, water, moisture. If units will be stored for more than 6 months, follow manufacturer's instruction for long-term storage.
- F. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 SEQUENCING AND SCHEDULING

- A. Coordinate installation of equipment located in building. Contractor shall coordinate with existing conditions of facility to determine shipping splits of all unit components to bring equipment into building. Contractor is solely responsible for any required disassembly and reassembly of equipment to install new

equipment. Disassembly and reassembly shall be performed by a manufacturer's factory-trained and factory-employed service technician only.

1.8 EXTRA MATERIALS

- 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 for each blower coil unit.
- B. Filters: Furnish one (1) additional set for each blower coil unit. This shall include complete sets of pre-filters and final filters as described below for each blower coil unit.
- C. Gaskets: Furnish one (1) additional complete set for each access door on each blower coil unit.
- D. Lighting: Provide six (6) matching light fixtures matching unit install type.
- E. Fan Belts: Furnish one (1) additional complete set for each blower coil unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Daikin Applied.
 - 2. Johnson Controls, Inc. (including York brand).
 - 3. Trane Technologies plc.

2.2 BLOWER COIL UNITS

- A. General Description: Factory assembled, consisting of fan, motor and drive assembly, chilled water cooling coil, hot water heating coil, filters and drain pans.
- B. Cabinet: Cabinet shall be constructed of minimum 18-gauge galvanized steel, double-wall insulated with 1-inch panels. The cabinet is to be thermally isolated through injected foam for insulation inside each panel. Panel shall have a minimum thermal insulation of R-6.5.
- C. Fans: Fan shall be forward curved, centrifugal blower type, equipped with heavy-duty adjustable speed V-belt drive. The fan shaft shall be supported by heavy-duty, permanently lubricated and sealed ball bearings.
- D. Motors: Motor shall be open drip-proof with permanently sealed ball bearings; internal current and thermal overload protection, a minimum 1.15 service factor and 56 frame resilient base.
- E. Coil Sections: Provide insulated, galvanized steel casings for cooling coil and heating coil. Design and construct to facilitate removal and replacement of coils for maintenance and to assure full airflow through coils.
- F. Coil Construction: Rigidly supported across full face, pitched to allow drainage.
 - 1. Coil Casing: Same as cabinet construction, but with all stainless steel materials for cooling coil sections. Coil header and return bend casings for chilled water shall be stainless steel.
 - 2. Coil Construction: Rigidly supported across full face, pitched to allow drainage.
 - 3. Circuit Arrangement: Self-draining and self-venting coil fabricated according to ARI 410. Number of rows shall be determined by manufacturer to meet scheduled performance requirements unless noted otherwise.
 - 4. Piping Connections: Threaded on same side. Coil connections shall be on the side of the unit indicated on the Drawings.
 - 5. Tubes: Copper, 5/8" O.D. with 0.025" minimum wall thickness. Select coils for not less than 1 fps water velocity and not more than 6 fps water velocity.
 - 6. Fins: Aluminum of minimum thickness 0.006". Spacing shall not exceed 8 per inch for heating coils nor 10 per inch for cooling coils.
 - 7. Fin and Tube Joint: Mechanical bond created via thermal expansion.
 - 8. Headers: Chilled water coil header shall be stainless steel. Heating coil shall be non-ferrous, such as seamless copper tube with brazed joints. Provide drain and air vent tapings. Headers and return bends shall be enclosed within the air handling unit casing.
 - 9. Frames: Stainless steel, 0.0625 inch (1.58 mm) is required for cooling coils. Galvanized-steel channel frame, 0.052 inch (1.3 mm) is acceptable for heating coils.
 - 10. Ratings: Design tested and rated according to ASHRAE 33 and ARI 410.
 - 11. Working-Pressure Ratings: 200 psig (1380 kPa), 325°F (163 C).
 - 12. Source Quality Control: Factory test coils to 315 psig (2070 kPa) air pressure under warm water, according to ARI 410, "Forced-Circulation Air-Cooling and Air-Heating Coils."
 - 13. Drain Pan: Provide stainless steel, insulated pan, sloped in both directions and fully drainable.

- G. Filters: 2-inch- (50-mm-) thick, high density glass micro fibers laminated to an all glass woven mesh backing with welded wire media support grid, clean airflow resistance of 0.10 inch wg (25 Pa) at face velocity of 300 fpm (1.52 m/s), and ASHRAE 52.1 filter-arrestance efficiency of 70 to 82 percent. Filters shall be Farr 30/30 or equal by American Air Filter. All filters shall be 24 inches by 24 inches or 24 inches by 12 inches, where possible.
- H. Unit Controls: Unit shall be supplied with digital controls ready interface. This interface is to be located inside control box internal to the main unit. This interface shall include a 24 VAC transformer and terminal blocks for connections to fan motor control, sensor control, safety switches, valve actuators and damper controls.
- I. Condensate Overflow Switch: Provide unit with condensate overflow switch factory wired for field mounting in an auxiliary drain pan to shut off the supply fan in the event of condensate overflow from the main pan to the auxiliary pan.
- J. Disconnect Switch: Provide a factory-installed and pre-wired NEMA 1 non-fused disconnect switch.
- K. All piping connections, filter access, controls shall be from one side of the unit.
- L. Unit shall be horizontal configuration and hung in space by spring isolators.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of piping systems and electrical services to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install factory-packaged air-handling units level and plumb, according to manufacturer's written instructions.
- B. Access and service shall comply with International Mechanical Code section 306. Arrange installation of units to provide access space around air-handling units for service and maintenance. A minimum 48 inches (1220 mm) clearance is required on side for fan access, filter access and coil access. A minimum of 24 inches (610 mm) of access space shall be provided on opposite side of unit from a where motor, coil, and filter access is provided. Provide Manufacturer's recommended motor, coil and filter access if more than described above.
- C. Adjust damper linkages for proper damper operation.
- D. Maintain specified filters in air handling units throughout construction to prevent dust and debris from entering of units.

3.3 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 machine to allow service and maintenance.
 - 1. Coil piping shall not block access doors.
 - 2. Coil piping connections shall be on opposite side of coil removal.
- C. Connect condensate drain pans using NPS 1¼ (DN 32), Type L copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
- D. Hot-, and Chilled-Water Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping." Connect to supply and return coil tappings with shutoff or balancing valve and union or flange at each connection.
 - 1. Hydronic piping shall be connected to hydronic coils in a counterflow arrangement, such that direction of water flow is opposite the direction of air flow.
- E. Steam and Condensate Piping: Comply with applicable requirements in Division 23 Section "Steam and Condensate Piping." Connect to supply and return coil tappings with shutoff valve and union or flange at each connection.

- F. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connections.
- G. Electrical: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls. Connect wiring and ground equipment according to Division 26 Sections.
 - 1. Connect fan motors to wiring systems and ground. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- H. Temperature control wiring and interlock wiring is specified in Division 23 Section "Control Systems."

3.4 CLEANING

- A. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.
- B. Clean modular packaged air-handling units internally, on completion of installation, according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Remove paint splatters and other spots. Repair damaged finish to match original finish. Vacuum clean fan wheels, cabinets, and coils entering air face. Comb all hydronic coils straight.
- C. After completing system installation and testing, adjusting, and balancing modular packaged air-handling and air-distribution systems, clean filter housings and install new filters.

3.5 COMMISSIONING

- A. Final Checks before Startup: Perform the following before startup:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete. Verify that proper thermal overload protection is installed in motors, starters, and disconnects.
 - 3. Verify integrity of condensate trap for positive or negative pressures operation.
 - 4. Verify filter gages are set to zero.
 - 5. Perform cleaning and adjusting specified in this Section.
 - 6. Disconnect fan drive from motor, verify proper motor rotation direction, and verify free fan wheel rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
 - 7. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
 - 8. Comb coil fins for parallel orientation.
 - 9. Install new filters of the specified type in each air handling unit.
 - 10. Verify that manual and automatic volume control, and fire dampers in connected ductwork systems are in fully open position.

END OF SECTION 23 7313

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SECTION 23 8216 – DUCT-MOUNTED COILS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes stand-alone duct-mounted heating and cooling coils that are not part of any packaged piece of equipment; of the following types:

- 1. Hydronic Air Coils.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 23 0100 "Basic Mechanical Requirements," and Section 23 0500 "Basic Mechanical Materials and Methods" all apply to the work of this Section as if fully repeated herein.
- C. See other Division 23 Sections for specification of heating and cooling coils that are factory-installed as part of packaged equipment.

1.3 SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil. Include rated capacities, operating characteristics, and pressure drops for each air coil.
- B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which coil location and ceiling-mounted access panels are shown and coordinated with each other.
- C. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

1.4 REFERENCED STANDARDS

- A. ASHRAE Compliance: Comply with applicable requirements in ASHRAE 62.1, Section 5 – "Systems and Equipment" and Section 7 – "Construction and Startup."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Hydronic Coils: Subject to compliance with requirements, provide products by one of the following.
 - 1. Aerofin.
 - 2. Diakin Applied.
 - 3. Dunham-Bush, Inc.
 - 4. Greenheck Fan Corporation.
 - 5. Heatcraft Worldwide.

2.2 HYDRONIC COILS

- A. Performance Ratings: Tested and rated according to AHRI 410 and ASHRAE 33.
- B. Minimum Working-Pressure/Temperature Ratings: 200 psig (1380 kPa), 325°F (163°C).
- C. Source Quality Control: Factory tested to 300 psig (2070 kPa) air under water.
- D. Tubes: Copper 5/8-inch O.D. with 0.025-inch minimum wall. Select coils for not less than 1 fps water velocity and not more than 6 fps water velocity.
- E. Provide coils with copper tube return bends with the final minimum thickness of 0.035 inch for 5/8 inch diameter tubing.
- F. Fins: Aluminum of minimum thickness 0.006-inch. Spacing shall not exceed 8 per inch for heating coils.
- G. Headers: Seamless copper tube with brazed joints, prime coated.

- H. Frames (Heating Coils): Galvanized-steel channel frame, minimum 20-gauge thickness, for flanged mounting.
- I. Duct mounted access door shall be installed upstream and downstream of all hydronic coils.
- J. Circuit Arrangement: Self-draining and self-venting coil fabricated according to AHRI 410. Number of rows shall not be less than two (2) rows unless noted otherwise.

2.3 DUCT-MOUNTED COIL CONTROLS

- A. Thermostats, control valves, and other devices associated with control of duct-mounted coils are specified in Division 23 Section "Control Systems."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install coils level and plumb.
- B. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."
- C. Straighten bent fins on air coils.
- D. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Do not connect coils to piping with flexible hoses of any type unless expressly detailed on Drawings.
- B. Arrange the piping adjacent to coils to allow access for service and maintenance.
- C. Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping.
- D. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Operational Test: After electrical circuitry has been energized, operate electric coils to confirm proper unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Prepare test and inspection reports.

END OF SECTION 23 8216

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

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. Electrical equipment coordination and installation.
 - 2. Common electrical installation requirements.

1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

1.4 COORDINATION

- A. Coordinate arrangement, mounting, and support of electrical equipment:
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping and conduit installed at required slope.
 - 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

PART 2 - PRODUCTS

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to piping systems installed at a required slope.
- F. Leave protective covers on luminaire lenses and reflectors until ready for final cleaning so that they do not get damaged and/or scratched from construction dust. Wipe all surfaces down including inside of lenses to ensure free of construction debris prior to final turn over.

3.2 SLEEVE AND/OR SLEEVE-SEAL INSTALLATION FOR ELECTRICAL RACEWAY AND CABLING PENETRATIONS

- A. Install sleeves and/or sleeve-seals as specified in Division 26 Section "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.3 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 260500

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SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

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. Copper building wire rated 600 V or less.
 - 2. Metal-clad cable, Type MC, rated 600 V or less.
 - 3. Connectors, splices, and terminations rated 600 V and less.

1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber
- B. NBR: Acrylonitrile-butadiene rubber
- C. RoHS: Restriction of Hazardous Substances.
- D. VFC: Variable-frequency controller.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Schedule: Indicate type, use, location, and termination locations.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Alcan Products Corporation; Alcan Cable Division.
 - 2. American Insulated Wire Corp.; a Leviton Company.
 - 3. Encore Wire
 - 4. General Cable Corporation.
 - 5. Senator Wire & Cable Company.
 - 6. Southwire Company.
- C. 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."
- D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
- E. Conductor Insulation:
 - 1. Type THHN and Type THWN-2: Comply with UL 83. (Minimum insulation rating shall be 90 deg C)
- F. Conductor Size: Minimum conductor size for branch circuits to be #12 awg.

2.2 METAL-CLAD CABLE, TYPE MC

- A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Alcan Products Corporation; Alcan Cable Division.
 - 2. American Insulated Wire Corp.; a Leviton Company.
 - 3. Atkore, Inc.
 - 4. Encore Wire
 - 5. General Cable Corporation.

- 6. Senator Wire & Cable Company.
- 7. Southwire Company.
- C. 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."
- D. Circuits:
 - 1. Single circuit.
 - 2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.
- E. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
- F. Conductor Size: Minimum conductor size for branch circuits to be #12 awg.
- G. Ground Conductor: Insulated.
- H. Conductor Insulation:
 - 1. Type TFN/THHN/THWN-2: Comply with UL 83.
- I. Armor: Aluminum, interlocked.
- J. Jacket: PVC applied over armor.
- K. MC cable may be used where permitted per Code and as limited under the Execution Section.

2.3 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors and splices 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Hubbell Power Systems, Inc.
 - 3. O-Z/Gedney; EGS Electrical Group LLC.
 - 4. 3M; Electrical Products Division.
 - 5. Tyco Electronics Corp.
- C. Use of 3M ScotchLok connectors or push-in wire connectors (similar to WAGO push-in connectors) are not permitted. All wiring to be done with wire nut type connectors.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper; 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.

3.2 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. Metal-clad cable, Type MC may be used only as permitted below.
 - 1. MC cable installed per NFPA 70.
 - 2. Installed with listed fittings permissible by manufacturer.
 - 3. Homeruns from power source to areas served shall be run in conduit.
 - a. Conduit shall be run from the source of power to an accessible above ceiling j-box **within** room or area to be served by MC cable.
 - b. MC lengths shall be limited to 50ft within the space served.
 - c. Anti-short bushings to be provided at terminations.
 - 4. Metal-clad cable, Type MC cable for lighting fixture whips up to 6'-0" long. They must be dedicated whips.

- a. Cable with 0-10 volt conductors may be used for lighting
 - b. No more than two MC cables to be terminated per light fixture.
- 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.
- J. All Fire alarm wiring to be installed in RED conduit.

3.3 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. Splicing: No splicing or joints will be permitted in either feeder or branch circuits except within outlet or accessible junction boxes.
- D. 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.
- E. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- F. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- G. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

3.4 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. Conductors shall be continuous from outlet to outlet. No splices shall be made except within outlet box or accessible junction boxes.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.

3.5 CONDUCTOR ARCPROOFING

- A. Cover two or more power feeder cables occurring in the same switchboard section, junction box or pullbox with arcproof and flameproof tape.
- B. Provide 3M Company "Scotch No. 77 tape or Plymouth Rubber Co. slipknot No. 30 tape, to provide an installation capable of withstanding a 200-amp arc for not less than 30 seconds.
- C. Apply tape in single layer, one-half lapped, or as recommended by the manufacturer to conform to the above requirements. Apply with the coated side next to the cable and hold in place with a random wrap of ½ inch wide, pressure sensitive, glass cloth electrical tape, 3M company "Scotch" No. 69. Tape to be color coded.

3.6 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.

3.7 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."

3.8 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."

3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors over **100 amps** 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.
- B. Cables will be considered defective if they do not pass tests and inspections.
- C. 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 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

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: Grounding systems and equipment.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:
 - 1. Grounding arrangements and connections for separately derived systems.
- C. Field quality-control reports.
- D. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Instructions for periodic testing and inspection of grounding features at grounding connections for separately derived systems based on NETA MTS.
 - a. Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
 - b. Include recommended testing intervals.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 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 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 wide and 1/16 inch thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

2.2 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. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel, sectional type; 3/4 inch by 10 feet in diameter.

PART 3 - EXECUTION

3.1 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. 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.
- C. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus on insulated spacers 2 inches minimum from wall, 6 inches 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 to specified height above floor; connect to horizontal bus.
- D. 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.

3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. 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.
- C. 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.
- D. 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.
- E. 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.
- F. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.
 - 1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 - 2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch grounding bus.
 - 3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.3 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 Rods: Drive rods until tops are 2 inches 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.
- C. 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.
- D. 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.
 - E. 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.
 - F. 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 apart.
- 3.4 **LABELING**
- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems" Article for instruction signs. The label or its text shall be green.
 - B. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.
 1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."
- 3.5 **FIELD QUALITY CONTROL**
- A. Perform tests and inspections.
 - B. 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. 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.
 - C. Grounding system will be considered defective if it does not pass tests and inspections.
 - D. Prepare test and inspection reports.
 - E. 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.
 - F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

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SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

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. Steel slotted support systems.
 - 2. Conduit and cable support devices.
 - 3. Support for conductors in vertical conduit.
 - 4. Structural steel for fabricated supports and restraints.
 - 5. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
- B. Related Requirements:
 - 1. Section 260548.16 "Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 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. Hangers and supports for electrical equipment and systems.
 - 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.

1.4 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.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.

PART 2 - PRODUCTS

2.1 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."
 2. Component Importance Factor: 1.0.
 3. Per Table 13.6-1 of the ASCE 7-10.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch- diameter holes at a maximum of 8 inches o.c. in at least one surface.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 - g. Wesanco, Inc.
 2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 3. Material for Channel, Fittings, and Accessories: Galvanized steel.
 4. Channel Width: Selected for applicable load criteria.
 5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
- 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. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 2. 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.
 3. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
 4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 5. Toggle Bolts: All-steel springhead type.
 6. Hanger Rods: Threaded steel.

PART 3 - EXECUTION

3.1 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 105.
- 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 in diameter.
- E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other 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.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.
- B. 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.
- C. 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. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
 6. To Light Steel: Sheet metal screws.
 7. 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.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than 4 inches 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, 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.

3.4 PAINTING

- A. Touchup: Comply with requirements in Section 099123 "Interior Painting" and Section 099600 "High-Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

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SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

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. Metal conduits, tubing, and fittings.
 - 2. Metal wireways and auxiliary gutters.
 - 3. Surface raceways.
 - 4. Boxes, enclosures, and cabinets.

1.3 DEFINITIONS

- A. GRC: Galvanized rigid steel conduit.
- B. IMC: Intermediate metal conduit.

1.4 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.

1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification 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.
- B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Allied Tube & Conduit; a Tyco International Ltd. Co.
 - 3. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - 4. Electri-Flex Co.
 - 5. O-Z Gedney; a unit of General Signal.
 - 6. Wheatland Tube Company.
 - 7. Republic Conduit.
 - 8. Southwire
- B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. GRC: Comply with ANSI C80.1 and UL 6.
- D. IMC: Comply with ANSI C80.6 and UL 1242.
- E. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
 - 1. Comply with NEMA RN 1.
 - 2. Coating Thickness: 0.040 inch, minimum.
- F. EMT: Comply with ANSI C80.3 and UL 797.
- G. FMC: Comply with UL 1; zinc-coated steel.
- H. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- I. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
 - 2. Fittings for EMT:

- a. Material: **Steel**.
- b. Type: **compression**.
- 3. 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.
- 4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
- J. 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.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - 3. CANTEX Inc.
 - 4. Electri-Flex Co.
 - 5. Lamson & Sessions; Carlon Electrical Products.
 - 6. RACO; a Hubbell Company.
 - 7. Thomas & Betts Corporation.
- B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. ENT: Comply with NEMA TC 13 and UL 1653.
- D. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- E. LFNC: Comply with UL 1660.
- F. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- G. Fittings for LFNC: Comply with UL 514B.
- H. Solvents and Adhesives: As recommended by conduit manufacturer.
 - 1. Solvent cements and adhesive primers shall have a VOC content of 510 and 550g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- 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:
 - 1. Cooper B-Line, Inc.
 - 2. Hoffman.
 - 3. Square D; Schneider Electric.
- B. 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.
- C. 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.
- D. Wireway Covers: Screw-cover type unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

2.4 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.**
- C. Surface metal raceway shall only be permitted where specifically indicated in the plans.
- D. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Thomas & Betts Corporation.
 - 2. Walker Systems, Inc.; Wiremold Company (The).
 - 3. Wiremold Company (The); Electrical Sales Division.

2.5 BOXES, ENCLOSURES, AND CABINETS

- 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:
 - 1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 - 2. EGS/Appleton Electric.
 - 3. Erickson Electrical Equipment Company.
 - 4. Hoffman.

5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
 6. O-Z/Gedney; a unit of General Signal.
 7. RACO; a Hubbell Company.
 8. Robroy Industries, Inc.; Enclosure Division.
 9. Scott Fetzer Co.; Adalet Division.
 10. Spring City Electrical Manufacturing Company.
 11. Thomas & Betts Corporation.
 12. Walker Systems, Inc.; Wiremold Company (The).
 13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.
- E. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
- H. Box extensions and mud ring covers used to accommodate new building finishes shall be of same material as recessed box.
- I. Device Box Dimensions: 4 inches square by 2-1/8 inches deep or 4 inches by 2-1/8 inches by 2-1/8 inches deep depending on device configuration or as noted on drawings. Provide mud ring covers as required for device installation.
- J. Gangable boxes are allowed.
- K. 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. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- L. 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.

PART 3 - EXECUTION

3.1 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, direct buried or concrete encased.
 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. Mechanical rooms on walls below 8' AFF.
 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: 3/4-inch 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 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. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- F. Install surface raceways only where indicated on Drawings.
- G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

- A. 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.
- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. 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 of changes in direction.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. Support conduit within 12 inches of enclosures to which attached.
- I. Raceways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch 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 intervals.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - 3. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.
 - 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
 - 5. Change from ENT to GRC before rising above floor.
- J. 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.
- K. 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.
- L. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- N. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- O. 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.
- P. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- Q. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- R. Surface Raceways:
 - 1. Install surface raceway with a minimum 2-inch radius control at bend points.
 - 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches 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.
- S. 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.

- T. 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. Where otherwise required by NFPA 70.
 - U. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
 - V. Expansion-Joint Fittings:
 - 1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
 - 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 temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
 - d. Attics: 135 deg F 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 of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.00078 inch per foot of length of straight run per deg F 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.
 - W. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches 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.
 - X. 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.
 - Y. 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.
 - Z. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
 - AA. Locate boxes so that cover or plate will not span different building finishes.
 - BB. 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.
 - CC. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
 - DD. Set metal floor boxes level and flush with finished floor surface.
 - EE. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
- 3.3 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."
- 3.4 FIRESTOPPING**
- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."
- 3.5 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 260533

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SECTION 260536 - CABLE TRAYS FOR ELECTRICAL/COMMUNICATIONS SYSTEMS

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. Wire-mesh cable tray.
 - 2. Cable tray accessories.
 - 3. Warning signs.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of cable tray.
 - 1. Include data indicating dimensions and finishes for each type of cable tray indicated.
- B. Shop Drawings: For each type of cable tray.
 - 1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
 - 2. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
 - a. Vertical and horizontal offsets and transitions.
 - b. Clearances for access above and to sides of cable trays.
 - c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
 - d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.
- C. Delegated-Design Submittal: For seismic restraints.
 - 1. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where project is located, who is responsible for their preparation.
 - 2. Design Calculations: Calculate requirements for selecting seismic restraints.
 - 3. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
 - 2. Vertical and horizontal offsets and transitions.
 - 3. Clearances for access above and to side of cable trays.
 - 4. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.
- B. Seismic Qualification Certificates: For cable trays, 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.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cable tray supports and seismic bracing.
- B. Seismic Performance: Cable trays and supports shall withstand the effects of earthquake motions determined according to **ASCE/SEI 7**.
 - 1. The term "withstand" means "the cable trays will remain in place without separation of any parts when subjected to the seismic forces specified."
 - 2. Component Importance Factor: **1.0**.
 - 3. Component Amplification Factor: Per Table 13.6-1 of the ASCE 7-10.

- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.
 - 1. Temperature Change: **120 deg F**, ambient; **180 deg F**, material surfaces.

2.2 GENERAL REQUIREMENTS FOR CABLE TRAYS

- A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
 - 1. Source Limitations: Obtain cable trays and components from single manufacturer.
- B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.
- C. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:
 - 1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
 - 2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
 - 3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.3 WIRE-MESH CABLE TRAY

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Chalfant Manufacturing Company.
 - 2. Cooper B-Line, Inc.
 - 3. Cope, T. J., Inc.; a subsidiary of Allied Tube & Conduit.
 - 4. GS Metals Corp.; GLOBETRAY Products.
 - 5. MONO-SYSTEMS, Inc.
 - 6. MPHusky.
 - 7. PW Industries.
 - 8. Legrand, Cablofil
- B. Description:
 - 1. Configuration: Galvanized-steel wire mesh, complying with NEMA VE 1.
 - 2. Width: **12 inches** unless otherwise indicated on Drawings.
 - 3. Minimum Usable Load Depth: **2 inches** unless otherwise indicated on Drawings.
 - 4. Straight Section Lengths: **10 feet**, except where shorter lengths are required to facilitate tray assembly.
 - 5. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
 - 6. Class Designation: Comply with NEMA VE 1, **Class (75lbs/ft) minimum**
 - 7. Splicing Assemblies: Bolted type using serrated flange locknuts.
 - 8. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
- C. Materials and Finishes:
 - 1. Steel:
 - a. Straight Sections and Fittings: Steel complies with the minimum mechanical properties of **ASTM A 1008/A 1008M, Grade 33, Type 2**.
 - b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
 - c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
 - d. Finish: Electrogalvanized after fabrication, complying with ASTM B 633.
 - 1) Hardware: Galvanized, ASTM B 633.

2.4 CABLE TRAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
- B. Barrier Strips: Same materials and finishes as for cable tray.
- C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.
- D. Provide **cable tray liner** where passing through exposed ceilings.

2.5 WARNING SIGNS

- A. Lettering: **1-1/2-inch** high, black letters on yellow background, with legend "WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL."
- B. Comply with requirements for fasteners in Section 260553 "Identification for Electrical Systems."

2.6 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect cable trays according to **NEMA VE 1**.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

- A. Install cable trays according to **NEMA VE 2**.
- B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.
- C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.
- D. Remove burrs and sharp edges from cable trays.
- E. Join aluminum cable tray with splice plates; use four square neck-carriage bolts and locknuts.
- F. Fasten cable tray supports to building structure **and install seismic restraints**.
- G. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems." **Comply with seismic-restraint details according to Section 260548.16 "Seismic Controls for Electrical Systems."**
- H. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.
- I. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
- J. Support bus assembly to prevent twisting from eccentric loading.
- K. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.
- L. Locate and install supports according to **NEMA VE 2**. Do not install more than one cable tray splice between supports.
- M. Support wire-basket cable trays with **trapeze hangers**.
- N. Support **trapeze hangers** for wire-basket trays with **3/8-inch** diameter rods.
- O. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.
- P. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in **NEMA VE 2**. Space connectors and set gaps according to applicable standard.
- Q. Make changes in direction and elevation using manufacturer's recommended fittings.
- R. Make cable tray connections using manufacturer's recommended fittings.
- S. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."
- T. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.
- U. Install cable trays with enough workspace to permit access for installing cables.
- V. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.
- W. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.
- X. Clamp covers on cable trays installed outdoors with heavy-duty clamps.
- Y. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

- A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."
- B. Cable trays shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- C. Cable trays with single-conductor power conductors shall be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72-inch intervals. The grounding conductor shall be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Trays."
- D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.
- E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

- A. Install cables only when each cable tray run has been completed and inspected.

- B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.
- C. Fasten cables on vertical runs to cable trays every 18 inches.
- D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches.
- E. Tie MI cables down every 36 inches where required to provide a 2-hour fire rating and every 72 inches elsewhere.

3.4 CONNECTIONS

- A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.
- B. Connect pathways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
 - 2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
 - 3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
 - 4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
 - 5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
 - 6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
 - 7. Check for improperly sized or installed bonding jumpers.
 - 8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
 - 9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.
- B. Prepare test and inspection reports.

3.6 PROTECTION

- A. Protect installed cable trays and cables.
 - 1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
 - 2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
 - 3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 260536

SECTION 260544 - 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. Grout.
- 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 minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- D. Sleeves for Rectangular Openings:
 - 1. Material: Galvanized sheet steel.
 - 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Products & Systems, inc.
 - b. CALPICO, Inc.
 - c. Metraflex Company (The)
 - d. Pipeline Seal and Insulator, Inc.
 - e. Proco Products, Inc.
 - f. Link-Seal
 - 2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 3. Pressure Plates: Reinforced Nylon.
 - 4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 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, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

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 annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
 - 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 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 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 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.

END OF SECTION 260544

SECTION 260548.16 - SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

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. Restraint channel bracings.
 - 2. Restraint cables.
 - 3. Seismic-restraint accessories.
 - 4. Mechanical anchor bolts.
 - 5. Adhesive anchor bolts.
- B. Related Requirements:
 - 1. Section 260529 "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by **an evaluation service member of ICC-ES**.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
- B. Delegated-Design Submittal: For each seismic-restraint device.
 - 1. Include design calculations and details for selecting seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 2. Design Calculations: Calculate static and dynamic loading caused by equipment weight, operation, and seismic forces required to select seismic restraints and for designing vibration isolation bases.
 - a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
 - 3. Seismic-Restraint Details:
 - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
 - d. Preapproval and Evaluation Documentation: By **an evaluation service member of ICC-ES**, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.
- B. Qualification Data: For **professional engineer and testing agency**.
- C. Welding certificates.
- D. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis. They shall bear anchorage preapproval from OSHPD in addition to preapproval, showing maximum seismic-restraint ratings, by ICC-ES or another agency acceptable to authorities having jurisdiction. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) that support seismic-restraint designs must be signed and sealed by a qualified professional engineer.
- E. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading:
 - 1. Site Design Category as Defined in the IBC: B.
 - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: III.
 - a. Component Importance Factor: 1.0.
 - b. Component Response Modification Factor: Varies Refer to ASCE7-16 Table 13.6-1.
 - c. Component Amplification Factor: Component Response Modification Factor: Varies Refer to ASCE7-16 Table 13.6-1.
 - 3. Design Spectral Response Acceleration at Short Periods (0.2 Second): 0.141.
 - 4. Design Spectral Response Acceleration at 1.0-Second Period: 0.094.

2.2 RESTRAINT CHANNEL BRACINGS

- A. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end, with other matching components, and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.3 RESTRAINT CABLES

- A. Restraint Cables: **ASTM A 603 galvanized**-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.4 SEISMIC-RESTRAINT ACCESSORIES

- A. Hanger-Rod Stiffener: **Steel tube or steel slotted-support-system sleeve with internally bolted connections** to hanger rod.
- B. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to **rigid channel bracings and restraint cables**.
- C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.
- D. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.
- E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.5 MECHANICAL ANCHOR BOLTS

- A. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.6 ADHESIVE ANCHOR BOLTS

- A. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by **an evaluation service member of ICC-ES**.
- B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods caused by seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in **Section 033000 "Cast-in-Place Concrete."**
- B. Equipment and Hanger Restraints:
 - 1. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 - 2. Install seismic-restraint devices using methods approved by **an evaluation service member of ICC-ES** providing required submittals for component.
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- E. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- F. Drilled-in Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 - 5. Set anchors to manufacturer's recommended torque using a torque wrench.
 - 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where connection is terminated to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: **Engage** a qualified testing agency to perform tests and inspections.
- B. Perform the following tests and inspections:
 - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
 - 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 - 4. Test at least **four** of each type and size of installed anchors and fasteners selected by Architect.
 - 5. Test to 90 percent of rated proof load of device.
- C. Seismic controls will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 260548.16

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

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. 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.

1.3 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. 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.
- C. Delegated-Design Submittal: For arc-flash hazard study.

PART 2 - PRODUCTS

2.1 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, ambient; 180 deg F, material surfaces.

2.2 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 and system or service type.
- B. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.
 - 1. Color shall be factory applied .
 - 2. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - d. Neutral: White
 - 3. Colors for 480/277-V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 - d. Neutral: Gray
 - 4. Color for Equipment Grounds: Green.
 - 5. 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."

2.3 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: Preprinted, 3-mil- 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: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.
- D. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil- 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 for raceway and conductors.
 - b. 3-1/2 by 5 inches for equipment.
 - c. As required by authorities having jurisdiction.

2.4 BANDS AND TUBES

- A. Snap-around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters and that stay in place by gripping action.

2.5 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 thick by 1 to 2 inches wide; compounded for outdoor use.
- C. Floor Marking Tape: 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.

2.6 TAGS

- A. Write-on Tags:
 - 1. Polyester Tags: 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment.
 - 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.7 SIGNS

- A. Metal-Backed Butyrate Signs:
 - 1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
 - 2. 1/4-inch grommets in corners for mounting.
 - 3. Nominal Size: 10 by 14 inches.
- B. Laminated Acrylic or Melamine Plastic Signs:
 - 1. Engraved legend.
 - 2. Thickness:
 - a. For signs up to 20 sq. in, minimum 1/16 inch.
 - b. For signs larger than 20 sq. in., 1/8 inch thick.
 - c. Engraved legend with black letters on white face.
 - d. Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting.
 - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.8 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.
 - 2. Tensile Strength at 73 Deg F according to ASTM D 638: 12,000 psi.
 - 3. Temperature Range: Minus 40 to plus 185 deg F.
 - 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 .
 - 2. Tensile Strength at 73 Deg F according to ASTM D 638: 12,000 psi.
 - 3. Temperature Range: Minus 40 to plus 185 deg F.
 - 4. Color: Black.
- C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 Deg F according to ASTM D 638: 7000 psi.
 - 3. UL 94 Flame Rating: 94V-0.
 - 4. Temperature Range: Minus 50 to plus 284 deg F.
 - 5. Color: Black.

2.9 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

3.1 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.

3.2 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- 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. "POWER/VOLTAGE."
 - 2. "EMERGENCY POWER."
 - 3. "FIRE ALARM SYSTEM POWER."
- 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- high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.
- Q. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.
- R. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.
- S. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.
- T. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.
- U. Write-on Tags:
 - 1. Place in a location with high visibility and accessibility.
 - 2. Secure using cable ties appropriate for location.
- V. 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- high letters on 1-1/2-inch- high sign; where two lines of text are required, use labels 2 inches high.
- W. 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- high letters on 1-1/2-inch- high sign; where two lines of text are required, use labels 2 inches high.
- X. Cable Ties: General purpose, for attaching tags, except as listed below:
 - 1. Outdoors: UV-stabilized nylon.
 - 2. In Spaces Handling Environmental Air: Plenum rated.

3.3 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. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120V to Ground: Identify with self-adhesive vinyl tape applied in bands.
 - 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- D. 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. "FIRE ALARM SYSTEM"
- E. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use self-adhesive wraparound labels to identify the phase.
 - 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- F. Power-Circuit Conductor Identification, More Than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic preprinted tags colored and marked to indicate phase, and a separate tag with the circuit designation.
- G. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with the conductor or cable designation, origin, and destination.
- H. Control-Circuit Conductor Termination Identification: For identification at terminations, provide self-adhesive labels with the conductor designation.
- I. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.
- J. 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.

- K. 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.
- L. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.
- M. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Metal-backed, butyrate warning signs.
 - 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.
- N. Arc Flash Warning Labeling: Self-adhesive labels.
- O. Operating Instruction Signs: Laminated acrylic or melamine plastic signs.
- P. Emergency Operating Instruction Signs: Laminated acrylic or melamine plastic signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer.
- Q. Equipment Identification Labels:
 - 1. Indoor Equipment: Laminated acrylic or melamine plastic sign.
 - 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 an **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. Power-transfer equipment.
 - n. Contactors.
 - o. Remote-controlled switches, dimmer modules, and control devices.
 - p. Battery-inverter units.
 - q. Battery racks.
 - r. Power-generating units.
 - s. Monitoring and control equipment.

END OF SECTION 260553

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SECTION 260572 - OVERCURRENT PROTECTIVE DEVICE SHORT-CIRCUIT STUDY

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 a computer-based, fault-current study to determine the minimum interrupting capacity of circuit protective devices.

1.3 DEFINITIONS

- A. 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.
- B. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- C. SCCR: Short-circuit current rating.
- D. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.4 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. Short-circuit study input data, including completed computer program input data sheets.
 - 2. Short-circuit study and equipment evaluation 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.
 - b. Single-line diagram, reflecting field investigation results and results of short-circuit study.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For **Short-Circuit Study Specialist**.
- B. Product Certificates: For short-circuit study software, certifying compliance with IEEE 399.

1.6 QUALITY ASSURANCE

- A. Studies shall use SKM Power Tools Electrical Engineering Software computer program (PTW32). Manual calculations or studies utilizing other software programs are not acceptable.
- B. Short-Circuit 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.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE

- A. Provide analysis performed by: SKM Systems Analysis, Inc., PTW 32, Latest software version.
- B. Comply with IEEE 399 and IEEE 551.
- C. Analytical features of fault-current-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.

2.2 SHORT-CIRCUIT 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.
6. Calculated X/R ratios and equipment interrupting rating (1/2 cycle) fault currents.
- D. Comments and recommendations for system improvements, where needed.
- E. Protective Device Evaluation:
 1. Evaluate equipment and protective devices and compare to short-circuit ratings.
 2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
 3. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
 5. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
- F. Short-Circuit Study Input Data: As described in "Power System Data" Article in the Evaluations.
- G. Short-Circuit Study Output:
 1. Short Circuit Study Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated fault-current magnitude and angle.
 - c. Show calculated X/R ratio and equipment interrupting rating (1/2 cycle fault currents on electrical distribution system diagram.
 2. Equipment Evaluation Report:
 - a. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 - b. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
 - c. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 3. Electronic models of all studies performed shall be turned over to the owner in digital format and shall include the complete SKM data files for the project.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Obtain all data necessary for the conduct of the study.
 1. Verify completeness of data supplied on the Riser diagram. Call any discrepancies to the attention of Engineer.
 2. For equipment provided that is Work of this Project, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
 3. For equipment **and** that **which** is existing to remain, 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 the short-circuit study. Comply with recommendations in IEEE 551 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 Project's overcurrent protective devices 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. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
 5. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
 6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.

7. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
8. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
9. Motor horsepower and NEMA MG 1 code letter designation.
10. Cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

3.2 SHORT-CIRCUIT STUDY

- A. Perform study following the general study procedures contained in IEEE 399.
- B. Calculate short-circuit currents according to IEEE 551.
- C. Base study on the device characteristics supplied by device manufacturer.
- D. The extent of the electrical power system to be studied is limited to the new and relocated panels as part of this project including the existing distribution panels where fed from.
- E. Begin short-circuit current 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. 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.
- H. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
 1. Switchgear and switchboard bus.
 2. Medium-voltage controller.
 3. Motor-control center.
 4. Distribution panelboard.
 5. Branch circuit panelboard.
 6. Three phase branch circuits with overcurrent protective devices installed with a rating equal to or greater than 30 amps.
 7. Motor circuit overcurrent protective devices for motors with a rating equal to or greater than 10 horsepower

3.3 ADJUSTING

- A. Make minor modifications to equipment as required to accomplish compliance with short-circuit study.

3.4 DEMONSTRATION

- A. Train Owner's operating and maintenance personnel in the use of study results.

END OF SECTION 260572

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SECTION 260573 - OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

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 computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.
- B. Study limited to new panels and breakers provided as part of this scope including panels where fed from.

1.3 DEFINITIONS

- A. 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.
- B. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- C. SCCR: Short-circuit current rating.
- D. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.4 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.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For **Coordination Study Specialist**.
- B. Product Certificates: For overcurrent protective device coordination study software, certifying compliance with IEEE 399.

1.6 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.

1.7 QUALITY ASSURANCE

- A. Studies shall use SKM Power Tools Electrical Engineering Software computer program (PTW32). Manual calculations or studies utilizing other software programs are not acceptable.
- B. 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.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE

- A. Provide analysis performed by: SKM Systems Analysis, Inc., PTW 32, Latest software version.
- 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.

2.2 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. Provide adequate time margins between device characteristics such that selective operation is achieved.
 - 6. Comments and recommendations for system improvements.
- H. **Coordination Study shall include the stamp or seal and signature of the preparing engineer, and shall be reviewed and approved by the Engineer of Record.**
- I. **Electronic models of all studies performed shall be turned over to the owner.**

PART 3 - EXECUTION

3.1 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. Submit preliminary coordination study analysis with equipment submittals.
 - a. The coordination analysis shall included but not be limited to:
 - 1) Service entrance equipment
 - a) All overcurrent protective devices installed in service entrance panels.
 - 2) Feeder Circuits
 - a) All three (3) phase Feeder circuit overcurrent protective devices installed with a rating equal to or greater than 30 amps.
 - 3) Branch Circuits.
 - a) All three (3) phase branch circuit overcurrent protective devices installed with a rating equal to or greater than 30 amps.
 - b) All motor circuit overcurrent protective devices for motors with a rating equal to or greater than 10 horsepower.
 2. Revise coordination study analysis after relevant equipment submittals have been approved.

Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study. Provide in both hardcopy and electronic disk format. The computer disk shall include the complete coordination file including all device curves (Use the SKM "Project-Backup" command).
 3. Prior to project completion, the coordination study and arc flash hazard analysis shall be provided in both hard copy and on USB drive. The hard copy shall include time current curves (for phase and ground fault settings) for each panel and the corresponding TCC report clearly showing each device set point. The digital format shall include the complete coordination file including all device curves (Use the SKM "Project-Backup" command). **The digital format shall include the complete SKM data files for the project.**

3.2 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. 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.
- E. 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.
- F. 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.
- G. 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.
- H. 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.
- I. Generator Protection: Select protection according to manufacturer's written recommendations and to IEEE 242.
- J. 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.
- K. 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. Unit substation primary and secondary terminals.
 4. Low-voltage switchgear.
 5. Motor-control centers.
 6. Standby generators and automatic transfer switches.
 7. Branch circuit panelboards.
- L. 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.

3.3 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 riser 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. 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. Maximum demands from service meters.
 13. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
 14. Motor horsepower and NEMA MG 1 code letter designation.
 15. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).
 16. Medium-voltage cable sizes, lengths, conductor material, and cable construction and metallic shield performance parameters.
 17. 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. Generator thermal-damage curve.
- e. Ratings, types, and settings of utility company's overcurrent protective devices.
- f. Special overcurrent protective device settings or types stipulated by utility company.
- g. Time-current-characteristic curves of devices indicated to be coordinated.
- h. 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.
- i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
- j. Panelboards, switchboards, motor-control center ampacity, and SCCR in amperes rms symmetrical.

3.4 FIELD ADJUSTING

- A. Make minor modifications to equipment as required to accomplish compliance with **short-circuit and** protective device coordination studies.

END OF SECTION 260573

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SECTION 260574 - OVERCURRENT PROTECTIVE DEVICE ARC-FLASH STUDY

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 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.

1.3 DEFINITIONS

- A. 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.
- B. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- C. SCCR: Short-circuit current rating.
- D. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.4 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** 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 initial 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.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For **Arc-Flash Study Specialist**.
- B. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.6 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.

1.7 QUALITY ASSURANCE

- A. Studies shall use SKM Power Tools Electrical Engineering Software computer program (PTW 32). Manual calculations or studies utilizing other software programs are not acceptable.
- B. 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.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE

- A. Provide analysis performed by: SKM Systems Analysis, Inc., PTW 32, Latest software version.
 - 1. Do not use the "Use Equipment Specific Arc Flash Equation in Protective Device Library" method for arc flash calculations in the SKM software.
- B. Comply with IEEE 1584 and NFPA 70E.
- 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.

2.2 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.

2.3 ARC-FLASH WARNING LABELS

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for self-adhesive equipment labels. Produce a waterproof, 3.5-by-5-inch self-adhesive, machine printed, 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. Source protective device name providing the protection (Indicate where equipment fed from).
 - 3. Nominal System Voltage.
 - 4. Arc Flash protection boundary.
 - 5. Bolted Fault Current.
 - 6. Hazard risk category.
 - 7. Specific Incident energy available (Worst Case).
 - a. For incident energy values less than or equal to 40 cal/cm², label shall indicate 'WARNING' using black lettering on orange background.
 - b. For incident energy values greater than 40 cal/cm², label shall indicate "DANGER" using white lettering with red background.
 - 8. Engineering report number, revision number, and issue date.
- C. Labels shall be machine printed, with no field-applied markings. Submit sample of label for **Owner Approval** prior to installation.
- D. Labels installed Outdoors shall be resistant to ultraviolet light.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance.
 - 1. Submit preliminary arc flash hazard analysis with equipment submittals.
 - a. The coordination and arc flash hazard analysis shall included but not be limited to:
 - 1) Service entrance equipment
 - a) All overcurrent protective devices installed in service entrance panels.
 - 2) Feeder Circuits
 - a) All three (3) phase Feeder circuit overcurrent protective devices installed with a rating equal to or greater than 30 amps.
 - 3) Branch Circuits.
 - a) All three (3) phase branch circuit overcurrent protective devices installed with a rating equal to or greater than 30 amps.
 - b) All motor circuit overcurrent protective devices for motors with a rating equal to or greater than 10 horsepower.
 - 2. **Revise** arc flash hazard analysis after relevant equipment submittals have been approved and as installed feeder lengths verified. Overcurrent protective devices that have not been submitted and approved prior to study may not be used in study. Provide in both hardcopy and electronic disk format. The computer disk shall include the complete coordination file including all device curves (Use the SKM "Project-Backup" command).
 - 3. Prior to project completion, the coordination study and arc flash hazard analysis shall be provided in both hard copy and on USB drive. The hard copy shall include time current curves (for phase and ground fault settings) for each panel and the corresponding TCC report clearly showing each device set point. The digital format shall include the complete coordination file including all device curves (Use the SKM "Project-Backup" command). **The digital format shall include the complete SKM data files for the project.**

3.2 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 Section 260572 "Overcurrent Protective Device Short-Circuit Study."
 - 2. Protective Device Coordination Study Report Contents: As specified 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.
 - 1. Identify any location other than the Service Entrance Main with a HCR>2 and provide recommendations for improvement.
- E. Include medium- and low-voltage equipment locations, except equipment rated 240-V ac or less fed from transformers less than 125 kVA.
 - 1. Switchgear and switchboard bus.
 - a. All overcurrent protective devices installed in service entrance panels.
 - 2. Motor-control center.
 - a. All motor circuit overcurrent protective devices for motors with a rating equal to or greater than 10 horsepower.
 - 3. Distribution panelboard.
 - 4. Branch circuit panelboard.
 - 5. Three phase branch circuits with overcurrent protective devices installed with a rating equal to or greater than 30 amps.
 - 6. Motor circuit overcurrent protective devices for motors with a rating equal to or greater than 10 horsepower
- 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.

J. **Arc flash hazard analysis shall include the stamp or seal and signature of the preparing engineer, and shall be reviewed and approved by the Engineer of Record.**

K. **Electronic models of all studies performed shall be turned over to the owner.**

3.3 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 riser 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.

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 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.

3.4 LABELING

A. Apply one **owner approved** arc-flash label for 600-V ac, 480-V ac, and applicable 208-V ac panelboards, disconnects and transformers.

END OF SECTION 260574

SECTION 260800 - ELECTRICAL COMMISSIONING REQUIREMENTS

PART 1 GENERAL

1.1 WORK INCLUDES

- A. Validation of proper installation of Divisions 26 systems and equipment
- B. Systems and equipment testing and startup
- C. Equipment performance verification
- D. Functional testing of control systems
- E. Documentation of tests, procedures and installations

1.2 SCOPE INCLUDES

- A. Systems to be commissioned include the following:
 - 1. Power Distribution [Panelboards and Transformers]
 - 2. Emergency Power
 - 3. Lighting Controls

1.3 RELATED DOCUMENTS

- A. Commissioning Plan - This plan is part of the Contract Documents and outlines many responsibilities, procedures and tasks throughout the commissioning process.
- B. Section 019113 – General Commissioning Requirements
- C. Section 230800 – Mechanical Commissioning Requirements
- D. Division 26 Sections - Individual Sections stipulate installation, startup, warranty and training requirements for the system or device specified in that Section.

1.4 REFERENCES

- A. ASHRAE Guideline 0-2013: The HVAC Commissioning Process.
- B. ANSI/NEBB S110-2019 - Whole Building Technical Commissioning of New Construction

1.5 GENERAL DESCRIPTION

- A. Commissioning is a process to assure all building systems are installed and perform interactively according to the design intent; the systems are efficient, cost effective and meet

the Owner's operational needs; the installation is adequately documented. Commissioning serves as a tool to minimize post-occupancy operational problems. It establishes testing and communication protocols in an effort to advance building systems from installation to fully optimized operation.

- B. The Commissioning Authority will work with the Contractor and Design Engineer to coordinate, oversee, and document the commissioning process during the Construction Phase of this project.
- C. This Section defines responsibilities of the Contractor to facilitate the commissioning process particularly during the Construction Phase of the project.

1.6 DEFINITIONS

- A. Refer to specification section 019113 for definitions related to the commissioning process.

1.7 DOCUMENTATION

- A. Contractor shall send Commissioning Authority one copy of the following per the procedures specified in other sections of the Specification:
 - 1. Shop drawings and product data related to systems and equipment to be commissioned on this project. CxA will review and incorporate comments via the Design Engineer.
 - 2. Initial draft of equipment startup plan checklists along with manufacturers' startup procedures. CxA will assist in development and recommend approval.
 - 3. System Test Reports. CxA will review and compile prior to FPT.
 - 4. System certificate of readiness including completed equipment startup forms along with the manufacturers' field or factory performance test documentation. CxA will review and approve prior to FPT.

1.8 SEQUENCING AND SCHEDULING

- A. Systems can be in various stages of the commissioning process where appropriate, in order to expedite close out of the facility. The CxA and Contractor shall cooperate to schedule Cx tasks to minimize the duration of Cx activities. Sequential priorities shall be followed per the Cx Plan.
- B. Commissioning Schedule - Contractor shall incorporate the commissioning process into the project schedule. Startup, TAB and FPT shall be itemized as applicable for each system. Durations for each task shall be coordinated with the CxA.

1.9 COORDINATION MANAGEMENT PROTOCOLS

- A. Coordination responsibilities and management protocols relative to Cx are initially defined in the Cx Plan but will be refined and documented at the commissioning scoping meeting. Contractor shall have input to the protocols and all parties will commit to scheduling obligations. The CxA will record and distribute notes from the meeting.

1.10 CONTRACTOR RESPONSIBILITIES

A. Construction Phase

1. Include commissioning requirements in price and plan for work.
2. Attend scoping and coordination meetings scheduled by the CxA.
3. Remedy deficiencies identified during the construction period.
4. Prepare and submit required draft forms and equipment information requested by the CxA. Typically, this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation, start-up and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the CxA.
5. Assist in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
6. Provide limited assistance to the CxA in preparing the specific functional performance test procedures. Contractors shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
7. Where functional testing is to be executed by the system/equipment provider (see "Systems/Equipment to be Commissioned") the Contractor, with the CxA's assistance, will develop final functional test checklists for each system, subsystem, or equipment including interfaces and interlocks, and include a separate entry, with space for comments, for each item to be tested.
8. Thoroughly complete and inspect installation of systems and equipment in accordance with the Contract Documents, reference or industry standards, and specifically Part 3 of this Section.
9. Startup systems and equipment prior to verification and performance testing by the CxA. Startup procedures shall be in accordance with Contract Documents, reference or industry standards, and specifically Part 3 of this Section.
10. Record startup and test procedures on startup forms and checklists and certify the systems and equipment have been started and tested in accordance with the Contract Documents, reference or industry standards, and specifically Part 3 of this Section. Each form shall be signed and dated by the individual responsible for the startup or test.
11. Complete pre-approved startup checklists and submit along with other installation certification documentation such as certificate of readiness, warranties, test results, etc.
12. Schedule and coordinate Cx efforts required by appropriate subcontractors and vendors.
13. Demonstrate the systems as specified.
14. Certify systems have been installed and are operating per Contract Documents through certificates of readiness.
15. Maintain an updated set of record documentation.

16. Copy CxA on indicated documentation.
 17. Conduct equipment operation, maintenance, diagnosis and repair training as required by the respective section of the Specifications.
- B. Acceptance Phase
1. Assist CxA in verification and performance testing. Assistance will generally include the following:
 - a. Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.
 - b. Manipulate systems and equipment to facilitate testing.
 - c. Manipulate control systems to facilitate verification and performance testing.
 2. Correct any work not in accordance with Contract Documents and non-conformances included in the commissioning issues log.
- C. Warranty Phase
1. Provide warranty service.
 2. Correct any deficiencies identified.
 3. Update record documentation to reflect any changes made throughout the Warranty Phase.

1.11 CONTRACTOR NOTIFICATION

- A. Contractor shall completely install, thoroughly inspect, startup systems and equipment. All activities shall be documented on specified forms. Contractor shall notify Design Engineer, Owner and CxA via the certification of readiness that systems are complete and ready for verification and functional performance testing.
- B. Contractor shall notify CxA at least 10 business days in advance of any tests or startups. CxA shall witness selected tests and startups.

1.12 STARTUP CHECKLISTS

- A. Startup checklists for each type of equipment and system shall be submitted to CxA for approval prior to startup. The forms shall be designed by the appropriate subcontractors or vendors to meet the requirements of the Contract Documents. Forms shall be developed for the specific equipment being installed for this project.
- B. Startup checklists shall generally include the following for each (as applicable):
1. Project specific designation, location and service
 2. Pertinent nameplate data
 3. Indication of the party performing the test
 4. Field for signature of the startup technician along with the date

5. Clear explanation of the inspection, test, measurement, etc. with a pass/fail indication and a record of measurement parameters
 6. Checklist space that proper maintenance clearances have been maintained
 7. Checklist space indicating that any required special tools and/or spare tools were turned over to the Owner
 8. Checklist space indicating that required prerequisite equipment and systems were successfully started.
- C. Startup checklists shall incorporate the manufacturer-specified procedures. Contractor shall compile the startup and checkout procedures indicated in the manufacturer's documentation prior to designing the forms. Include specified acceptance criteria as applicable. The manufacturer's startup and checkout procedures shall be submitted to the CxA along with the draft startup checklists.
- D. Completed startup plans for all pieces of equipment included in a system shall be submitted to CxA prior to verification and performance testing.
- E. See specification 019113 for additional information regarding Startup Checklists.

1.13 FUNCTIONAL PERFORMANCE TESTING

- A. Participation: CxA will coordinate, test and/or witness functional performance tests after the successful startup and documentation of systems and equipment is complete. Contractor shall assist, as described above, with manipulation of the systems or equipment; provision of supporting equipment or materials (lifts, ladders, specialty test equipment, etc.); and on the spot remediation of minor identified deficiencies.
- B. Detailed Test Forms: CxA will prepare detailed testing procedures and forms to conduct and document the FPT. These will be developed during the Construction Phase and completed during the Acceptance Phase.
- C. Test Documentation: CxA will record test results on the forms developed for the testing. CxA will Pass or Fail the testing and record the date and time of the test. Deficiencies shall clearly indicate when the test has failed. CxA shall recommend acceptance of the system or component after all related testing is successfully complete.
- D. Deficiencies and Retesting: When deficiencies are identified during testing, depending on their extent or magnitude, they can be corrected during the test and the testing can continue to successful completion. Significant deficiencies will fail the test and require retesting of the affected portions of the test. The CxA will subsequently track the resolution of the deficiency via the Project Deficiency List. All tests shall be repeated until successful completion.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 GENERAL

- A. This Section outlines specific startup, checkout, and functional testing requirements for systems and equipment. Generally, these procedures are the direct responsibility of the Contractor as a basic element of validating that the installation is correct. These requirements along with those specified in the individual Section provide a minimum guideline for development of startup procedures, checklists and tests. Contractor shall synthesize these requirements with that of the manufacturer's and/or applicable codes and standards to develop specific and itemized startup procedures specific to that installed on this project.
- B. Refer to all Division 26 Specifications for tests performed on installed equipment and systems.

3.2 STARTUP

- A. The contractor shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section and in 019113. The Contractor has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the commissioning authority or Owner.
- B. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the CxA and Contractor. Beginning system testing before full completion does not relieve the Contractor from fully completing the system, including all startup plan checklists as soon as possible.

3.3 STARTUP/CHECKOUT

- A. Verify that equipment testing work is complete before starting functional performance of power equipment.
- B. Inspect equipment and confirm that it is clean and ready for operation. All shipping tags removed, nameplates installed and equipment manuals in place.
- C. Verify all equipment labeling corresponds with drawings and indices and meets required Specifications. Correct any deficiencies for electrical systems.

3.4 POWER DISTRIBUTION – STARTUP/CHECKOUT

- A. Overcurrent protective device settings coordinated and adjusted per the study results.
- B. System in place and tested, including all components indicated.
- C. Connected to utility company power system on a permanent basis.
- D. Wiring installed in conduits or other raceways.
- E. System checked for unwanted grounds, short circuits or open circuits.
- F. Ground installed as indicated, including transformers.

- G. Equipment connections properly torqued.
- H. Equipment, where indicated, on housekeeping pads.
- I. Equipment cleaned and shipping blocks removed.
- J. Equipment labeled.
- K. Boxes and nameplates meet color coding requirements.

3.5 LIGHTING CONTROLS – STARTUP/CHECKOUT

- A. System in place and tested, including all components indicated.
- B. Wiring installed in conduits or other raceways.
- C. System check for unwanted grounds, short circuits or open circuits.
- D. Grounds installed as indicated.
- E. Equipment labeled.
- F. Boxes and nameplates meet color coding requirements.
- G. Connected to emergency power system where required.
- H. New portion of system connected and interfaced with existing lighting control system.
- I. Verify system has been inspected and given approval by jurisdictional authority.

3.6 FUNCTIONAL TESTING

- A. This section specifies the functional testing requirements for Division 26 systems and equipment. From these requirements, the Commissioning Authority (CxA) shall develop step-by-step procedures to be executed by the Contractors or the Commissioning Authority. The general functional testing process, requirements and test method definitions are described in Section 019113. The test requirements for each piece of equipment or system contain the following:
 - 1. The contractors responsible to execute the tests, under the direction of the CxA
 - 2. A list of the integral components being tested
 - 3. Startup plan checklists associated with the components
 - 4. Functions and modes to be tested
 - 5. Required conditions of the test for each mode
 - 6. Special procedures
 - 7. Required monitoring
 - 8. Acceptance criteria

B. PREREQUISITES

1. The following applicable generic prerequisite checklist items are required to be completed and submitted with the equipment/system certificate of readiness and checked off by CxA prior to functional testing.
2. All related equipment has been started up and startup plan checklists submitted and approved ready for functional testing.
3. All control system functions for this and all interlocking systems are programmed and operable per contract documents, including final setpoints and schedules with debugging, loop tuning and sensor calibrations completed.
4. Test and balance (TAB) complete and approved for the air and hydronic systems
5. All A/E punchlist items for this equipment corrected
6. Schedules and setpoints provided to the CxA
7. False loading equipment, system and procedures ready
8. Sufficient clearance around equipment for servicing

C. MONITORING

1. Monitoring is a method of testing as a stand-alone method or to augment manual testing.
2. All points listed in the required monitoring section of the test requirements which are control system monitored points shall be trended by the controls contractor. Other points shall be monitored by the CxA using dataloggers. At the option of the CxA, some control system monitoring may be replaced with datalogger monitoring. At the CxA's request, the controls contractor shall trend up to 20% more points than listed herein at no extra charge.
3. Trend output data must be in an ASCII delimited text file with time continuous down left column and point values in column(s) to the right.
4. All trends for points of a group must start at the same moment in time, unless specifically approved otherwise with the commissioning agent.

3.7 NORMAL POWER SYSTEMS FPT

A. Parties Responsible to Execute Functional Test

1. Electrical contractor: perform functional testing
2. CxA: to witness, direct and document testing.
3. Equipment manufacturer's representative, as required.
4. Owner's Representative
5. Owner's maintenance staff, as desired.

- B. Prerequisites: The applicable prerequisite checklist items listed in paragraph 3.7.B shall be listed on each certificate of readiness form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the startup plan checklists previously completed by the installer, before the beginning of functional testing.

- C. Functions / Modes Required to be Tested
 - 1. Activate system by connection to utility power.
 - 2. Verify voltages and amperes at meters on switchgear.
 - 3. Verify voltages and amperes at switchgear, switchboards, motor control centers, panelboards, and transformers, both primary and secondary.
 - 4. Verify voltages and amperes at mechanical motors and other major pieces of equipment.
- D. Results: If specified equipment performance is not achieved, the Contractor shall have corrections made and reschedule Functional Performance Test as soon as possible after corrective work is completed.
- E. Acceptance Criteria
 - 1. For the conditions, sequences and modes tested, the system, integral components, and related equipment respond to varying loads and changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

END OF REQUIREMENTS FOR POWER SYSTEMS TEST

3.8 LIGHTING CONTROL SYSTEM FPT

- A. Parties Responsible to Execute Functional Test
 - 1. Electrical contractor
 - 2. CxA: to witness, direct and document testing.
 - 3. Equipment manufacturer's representative, as required.
 - 4. Owner's Representative
 - 5. Owner's maintenance staff, as desired.
- B. Prerequisites: The applicable prerequisite checklist items listed in paragraph 3.6.B shall be listed on each certificate of readiness form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the startup plan checklists previously completed by the installer, before the beginning of functional testing.
- C. Functions / Modes Required to be Tested
 - 1. Demonstrate operation of lighting control system per specifications including the following:
 - a. Control switches
 - b. Dimming performance
 - c. Verify tie-in and proper system remote operation
 - d. Verify system function upon loss of power
- D. Results: If specified equipment performance is not achieved, the Contractor shall have corrections made and reschedule Functional Performance Test as soon as possible after

corrective work is completed.

E. Acceptance Criteria

1. For the conditions, sequences and modes tested, the system, integral components, and related equipment respond to varying loads and changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

END OF REQUIREMENTS FOR LIGHTING CONTROL SYSTEM TEST

END OF SECTION 260800

SECTION 260923 - LIGHTING CONTROL DEVICES

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. Indoor occupancy and vacancy sensors.
 - 2. Digital Photosensors
 - 3. Switchbox-mounted occupancy sensors.
 - 4. Digital timer light switches.
- B. Related Requirements:
 - 1. Section 262726 "Wiring Devices" manual light switches.

1.3 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.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Sample Warranty: For manufacturer's warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.

1.6 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 devices.
 - 2. Warranty Period: **Five** year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 DIGITAL TIME SWITCHES

- A. Basis of Design Product: Subject to compliance with requirements, provide product indicated on drawings or comparable product by one of the following Manufacturers:
 - 1. Cooper Industries, Inc.
 - 2. Intermatic, Inc.
 - 3. Lightolier Controls; a Genlyte Company
 - 4. Leviton Mfg. Company Inc.
 - 5. Watt Stopper (The).
 - 6. Hubbell
- B. Digital time switch
 - 1. The digital time switch shall be programmable to turn lights off after a preset time.
 - 2. Time switch shall be a completely self-contained control system that replaces the standard toggle switch. It shall have a ground wire and ground strap for safety. Switching mechanism shall be a latching air gap relay.
 - 3. Zero Crossing Circuitry shall be used to increase the relay life, protect from the effects of inrush current, and increase the switch's longevity.
 - 4. Time switch shall be compatible with all LED, electronic ballasts, ELV, MLV and motor loads. Triac and other harmonic generating devices shall not be allowed.
 - 5. Time switch shall operate at universal voltages of 100-300 VAC; 50/60 Hz.

6. Time switch shall have no minimum load requirement and shall be capable of controlling 0 to 800 watt incandescent, fluorescent @ 100/120 VAC, 50/60 Hz.
7. Time scroll feature shall allow manual overriding of the preset time-out period. Selecting time scroll UP shall allow time-out period to scroll up throughout the timer possibilities to the maximum. Time scroll DN (down) shall allow time-out period to scroll down to minimum.
8. Time switch shall have the option for a one second light flash warning at five minutes before the timer runs out and twice when the countdown reaches one minute (when used to control lighting loads).
9. Time switch shall have the option for a beep warning that shall sound every five seconds once the time switch countdown reaches one minute.
10. Time switch shall have manual feature for timer reset where pressing the ON/OFF switch for more than 2 seconds resets the timer to the programmed time-out period.
11. Time switch shall have an electroluminescent backlit Liquid Crystal Display that shows the timer's countdown.
12. Time switch shall fit behind a decorator style faceplate. The calibration switch for setting time-out, time scroll, one second light flash, and beep warning shall be concealed to prevent tampering of adjustments and hardware.
13. Time-out period shall be adjustable in increments of 5 minutes from 5 minutes to 1 hour, and in increments of 15 minutes from 1 hour to 12 hours.
14. Time switch shall be capable of operating as an ON/OFF switch.
15. For ease of installation and cleaner wiring, the switch shall utilize terminal style wiring.
16. The time switch shall not protrude more than 1/8" from the wall and should blend in aesthetically.
17. For safety, the time switch shall have a 100% OFF override switch with no leakage current to the load.
18. For safety, in the event there is an open circuit in the AC line such as a ballast or lamp failure, the time switch shall automatically switch to OFF mode.
19. To ensure quality and reliability, time switch shall be manufactured by an ISO 9002 certified manufacturing facility and shall have a defect rate of less than 1/3 of 1%.
20. Time switch shall have 5 year warranty and shall be UL and CUL listed.

2.2 DIGITAL OCCUPANCY CONTROL SYSTEM

- A. Basis of design product: Subject to compliance with requirements, provide Wattstopper Digital Lighting Management (DLM) system as indicated on Drawings:
 1. Contractor may submit prior to bid comparable products for pre-approval. Substitutions will not be entertained after submittal of bid.
- B. Digital Ceiling mounted occupancy sensor system.
 1. Ceiling mounted passive infrared (PIR), ultrasonic or dual technology digital (passive infrared and ultrasonic) occupancy sensor. Furnish the Company's system which accommodates the square-foot coverage requirements for each area controlled, utilizing room controllers, digital occupancy sensors and accessories which suit the lighting and electrical system parameters.
 2. Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:
 - a. Digital calibration and pushbutton programming for the following variables:
 - 1) Sensitivity – 0-100% in 10% increments
 - 2) Time delay – 1-30 minutes in 1 minute increments
 - 3) Test mode – Five second time delay
 - 4) Detection technology – PIR, Ultrasonic or Dual Technology activation and/or re-activation.
 - 5) Walk-through mode
 - 6) Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.
 - b. One or two RJ-45 port(s) for connection to DLM local network.
 - c. Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.
 - d. Device Status LEDs including:
 - 1) PIR Detection
 - 2) Ultrasonic detection
 - 3) Configuration mode
 - 4) Load binding
 - e. Assignment of occupancy sensor to a specific load within the room without wiring or special tools.
 - f. Manual override of controlled loads.
 3. Units shall not have any dip switches or potentiometers for field settings.
 4. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required.
 5. WattStopper product numbers: LMPX, LMDX, LMPC, LMUC, LMDC

C. DIGITAL PHOTSENSOR

1. Single zone switching and dimming closed loop digital photosensor
2. Photodiode with extended range of 1-1,553 footcandles (fc), and photopic correction to mimic the human eye for measurement of visible light.
3. Operates on class 2 power supplied to a DLM local network.
4. Current consumption: 7mA
5. Spatial response: 100 deg
6. Test mode override of programmed time delay allows for verification of settings.
7. Adjustable switching parameters include on and off setpoints and time delays.
 - a. Off setpoint adjustable to a value of 25, 50, 75 or 100 percent above the on setpoint.
8. Adjustable dimming parameters include day and night setpoints ramp up and down rates and a cut-off time delay.
9. Electric lights can be turned off or dimmed to a user selectable minimum level when daylight contribution is abundant.
10. Infrared (IR) transceiver for wireless configuration and control compatible with DLM wall switches for manual override.
11. Mounting options for hard ceilings, dropped ceilings and suspended light fixtures.
12. Wattstopper project number LMLS-400 or as listed in the lighting control schedule.

D. DIGITAL WALL SWITCHES

1. Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configuration; available in white, light almond, ivory, grey and black; compatible with wall plates with decorator opening. Wall switches shall include the following features:
 - a. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.
 - b. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
 - c. Red configuration LED on each switch that blinks to indicate data transmission.
 - d. Blue Load/Scene Status LED on each switch button with the following characteristics:
 - 1) Bi-level LED
 - 2) Dim locator level indicates power to switch
 - 3) Bright status level indicates that load or scene is active
 - e. Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.
2. Two RJ-45 ports for connection to DLM local network.
3. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required to achieve multi-way switching.
4. The following switch attributes may be changed or selected using a wireless configuration tool:
 - a. Load and Scene button function may be reconfigured for individual buttons (from Load to Scene, and vice versa).
 - b. Individual button function may be configured to Toggle, On only or Off only.
 - c. Individual scenes may be locked to prevent unauthorized change.
 - d. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
 - e. Ramp rate may be adjusted for each dimmer switch.
 - f. Switch buttons may be bound to any load on a room controller and are not load type dependant; each button may be bound to multiple loads.
5. WattStopper product numbers: LMSW-101, LMSW-102, LMSW-103, LMSW-104, LMSW-105, LMSW-108, LMDM-101.

E. ROOM CONTROLLERS

1. Room Controllers automatically bind the room loads to the connected devices in the space without commissioning or the use of any tools. Room Controllers shall be provided to match the room lighting load and control requirements. The controllers will be simple to install and will not have, dip switches, potentiometers or require special configuration. The control units will include the following features:
 - a. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.
 - b. Simple replacement – Using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf unit without requiring any configuration or setup.
 - c. Device Status LEDs to indicate:
 - 1) Data transmission
 - 2) Device has power
 - 3) Status for each load
 - 4) Configuration status
 - d. Quick installation features including:
 - 1) Standard junction box mounting

- 2) Quick low voltage connections using standard RJ-45 patch cable
 - e. Plenum rated
 - f. Manual override and LED indication for each load
 - g. Dual voltage (120/277 VAC, 60 Hz)
 - h. Zero cross circuitry for each load.
- 2. On/Off Room Controllers shall include:
 - a. One or two relay configuration
 - b. Efficient 150 mA switching power supply
 - c. Three RJ-45 DLM local network ports
 - d. Discrete model listed for connection to receptacles, for occupancy-based control of plug loads within the space.
 - e. One relay configuration only
 - 1) Automatic-ON/OFF configuration
 - f. WattStopper product numbers: LMRC-101, LMRC-102, LMPL-101
- 3. On/Off/Dimming enhanced Room Controllers shall include:
 - a. Real time current monitoring
 - b. One, two or three relay configuration
 - c. Efficient 250 mA switching power supply
 - d. Four RJ-45 DLM local network ports.
 - e. One 0-10 volt analog output per relay for control of compatible ballasts and LED drivers.
 - f. The following dimming attributes may be changed or selected using a wireless configuration tool:
 - 1) Establish preset level for each load from 0-100%
 - 2) Set high and low trim for each load
 - 3) Set lamp burn in time for each load up to 100 hours
 - g. Discrete model listed for connection to receptacles, for occupancy-based control of plug loads within the space.
 - 1) One relay configuration only
 - 2) Automatic-ON/OFF configuration
 - h. WattStopper product numbers: LMRC-211, LMRC-212, LMRC-213, LMPL-201, LMRC-311, LMRC-312, LMRC-313.
- F. ISOLATED RELAY INTERFACE
 - 1. Output interface for integration of third party systems
 - 2. Single pole double throw isolated relay
 - 3. Status LED for isolated relay
 - 4. Over current protection
 - 5. Two RJ45 ports with hinged dust cover
 - 6. UL 2043 plenum rated
 - 7. Watt Stopper product number: LMRL-100
- G. DIGITAL INTERFACE
 - 1. Operating voltage 24VDC from DLM network
 - 2. Maximum current consumption 15Ma
 - 3. DLM local network connection: 2 RJ45 ports
 - 4. Terminal block for connection to third party system. RS-232 Data Wiring.
 - 5. Baud rate configurable to 9600, 19200, 38400, 57600 or 115200
 - 6. Wattsoppper product number: LMDI-100
- H. ROOM NETWORK (DLM Local Network)
 - 1. The DLM local network is a free topology lighting control physical connection and communication protocol designed to control a small area of a building. Digital room devices connect to the network using CAT 5e cables with RJ-45 connectors which provide both data and power to room devices. Features of the DLM local network include:
 - a. Plug n' Go automatic configuration and binding of occupancy sensors, switches and lighting loads to the most energy-efficient sequence of operation based upon the device attached.
 - b. Simple replacement of any device in the network with a standard off the shelf unit without requiring commissioning, configuration or setup.
 - c. Push n' Learn configuration to change the automatic configuration, including binding and load parameters without tools, using only the buttons on the digital devices in the local network.
 - d. Two-way infrared communications for control by handheld remotes, and configuration by a handheld tool including adjusting load parameters, sensor configuration and binding, within a line of sight of up to 30 feet from a sensor, wall switch or IR receiver.
- I. CONFIGURATIONS TOOLS

1. A configuration tool facilitates optional customization of DLM local networks, and is used to set up open loop daylighting sensors. A wireless configuration tool features infrared communications, while PC software connects to each local network via a USB interface.
2. Features and functionality of the wireless configuration tool shall include:
 - a. Two-way infrared (IR) communication with DLM IR-enabled devices within a range of approximately 30 feet.
 - b. High visibility organic LED (OLED) display, pushbutton user interface and menu-driven operation.
 - c. Read, modify and send parameters for occupancy sensors, room controllers and buttons on digital wall switches.
 - d. Save up to nine occupancy sensor setting profiles, and apply profiles to selected sensors.
 - e. Temporarily adjust light level of any load(s) on the local network, and incorporate those levels in scene setting.
3. WattStopper Product Numbers: LMCT-100, LMCI-100/LMCS-100

2.3 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

- A. Basis of Design Product: Subject to compliance with requirements provide product as indicated on Drawings or pre-approved comparable product by one of the following:
 1. Bryant Electric; a Hubbell company.
 2. Cooper Industries, Inc.
 3. Hubbell Building Automation, Inc.
 4. Leviton Mfg. Company Inc.
 5. Lightolier Controls.
 6. Lithonia Lighting; Acuity Lighting Group, Inc.
 7. Lutron Electronics Co., Inc.
 8. Sensor Switch, Inc.
 9. Square D; a brand of Schneider Electric.
 10. Watt Stopper.
- B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, 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. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
 3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.
- C. Wall-Switch Sensor Tag 'MS':
 1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft.
 2. Sensing Technology: Dual technology - PIR and ultrasonic.
 3. Switch Type: SP.
 4. Voltage: Dual voltage, 120 and 277 V; dual-technology type.
 5. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
 6. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

2.4 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."
- D. Color coding of DLM System conductors shall be **WHITE**. Obtain pre-approval of color from owner prior to ordering.

PART 3 - EXECUTION

3.1 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.

3.2 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.

3.3 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 3/4 inch.
- 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.
- F. Provide **white colored** cable for all lengths when making DLM System connections with CAT5e with RJ45 connectors. Contractor shall submit cable color and obtain confirmation from owner prior to ordering.

3.4 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.

3.5 PROGRAMMING

- A. On a room by room basis, after approved programming is completed and verified, the lighting control system lock-out features on switches, sensors, etc. shall be enabled to prevent accidental re-programming and to maintain programmed scenes and sequences.
- B. System switches shall be configured for auto-on (and auto-off) control of associated lighting unless otherwise noted.

3.6 FIELD QUALITY CONTROL

- A. 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.
- B. Lighting control devices will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.7 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.
 - 2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.

3.8 FACTORY COMMISSIONING

- A. Upon completion of the installation, the system shall be commissioned by the manufacturer's factory authorized representative who will verify a complete fully functional system.
- B. The electrical contractor shall provide both the manufacturer and the electrical engineer with ten working days written notice of the system startup and adjustment date.
- C. After commissioning and after switches have been programmed, system lockout features shall be activated such that programming function is locked out to avoid unintentional re-setting of switches.

3.9 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 260923

SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

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: **Distribution**, dry-type transformers rated 600 V and less, with capacities up to 1500 kVA.

1.3 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.

1.4 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.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.

1.7 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

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ABB, Formally GE Industrial Solutions
 - 2. Eaton Electrical Inc.; Cutler-Hammer Products.
 - 3. Square D; Schneider Electric.
- B. Source Limitations: Obtain each transformer type from single source from single manufacturer.

2.2 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 DOE 2016 Standard for energy-efficiency levels as verified by testing according to the DOE Test Method for Measuring the Energy Consumption of Distribution Transformer under Appendix A to subpart K of 10 CFR part 431.
 - 1. 15 kVA 97.89% efficiency
 - 2. 30 kVA 98.23% efficiency
 - 3. 45 kVA 98.40% efficiency
 - 4. 75 kVA 98.60% efficiency
 - 5. 112.5 kVA 98.74% efficiency
 - 6. 150 kVA 98.83% efficiency
 - 7. 225 kVA 98.94% efficiency
 - 8. 300 kVA 99.02% efficiency
- 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: **Copper**.
- 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.

2.3 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 2**: 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: **One 5 percent tap above normal full capacity.**
- 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 four 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 **115**-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: **Manufacturer's standard brackets.**
- O. Low-Sound-Level Requirements: Maximum sound levels when factory tested according to IEEE C57.12.91, as follows:
 - 1. 9 kVA and Less: **40 dBA**.
 - 2. 30 to 50 kVA: **45 dBA**.
 - 3. 51 to 150 kVA: **50 dBA**.
 - 4. 151 to 300 kVA: **55 dBA**.
 - 5. 301 to 500 kVA: **60 dBA**.

6. 501 to 750 kVA: 63 **dB**A.

2.4 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."

2.5 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

3.1 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.

3.2 INSTALLATION

- A. Install wall-mounted transformers level and plumb with **wall brackets fabricated by transformer manufacturer.**
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** 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.

3.3 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.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. 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.
- C. Remove and replace units that do not pass tests or inspections and retest as specified above.
- D. 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.
- E. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 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.

3.6 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262200

SECTION 262416 - PANELBOARDS

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. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

- A. ATS: Acceptance testing specification.
- B. GFCI: Ground-fault circuit interrupter.
- C. GFEP: Ground-fault equipment protection.
- D. MCCB: Molded-case circuit breaker.
- E. SPD: Surge protective device.
- F. VPR: Voltage protection rating.

1.4 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 SPD as installed in panelboard.
 - 7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 8. Include wiring diagrams for power, signal, and control wiring.
 - 9. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft 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 in addition to electronic format compatible with SKM software; include selectable ranges for each type of overcurrent protective device.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Panelboard Schedules: For installation in panelboards. **Submit final versions after load balancing.**

1.6 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. Provide in electronic format compatible with SKM software.

1.7 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.

1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

1.9 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 **NEMA PB 1**.

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** to plus 104 deg F.
 - b. Altitude: Not exceeding 6600 feet.
- B. 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 **Owner** no fewer than **seven** days in advance of proposed interruption of electric service.
 - 2. Do not proceed with interruption of electric service without **Owner'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: **24** months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 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** or **Surface**-mounted (as noted on drawings), 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. **Wash-Down** Areas: NEMA 250, **Type 4X**.
 - 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 12**.
 - 2. Height: 84 inches 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. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
 - 6. Finishes:
 - a. Panels and Trim: **Steel and galvanized 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: Galvanized steel.
- 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: Hard-drawn copper, 98 percent conductivity.
 - 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. 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.
 - I. Conductor Connectors: Suitable for use with conductor material and sizes.
 1. Material: Hard-drawn copper, 98 percent conductivity.
 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. 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: **25** 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.
- 2.2 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**.
- 2.3 POWER PANELBOARDS**
- A. Manufacturers: Subject to compliance with requirements, **provide products by one of the following**:
 1. ABB, Formally GE Industrial Solutions
 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 3. Square D; a brand of Schneider Electric.
 - B. Panelboards: NEMA PB 1, distribution type.
 - C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
 1. For doors more than **36 inches** high, provide two latches, keyed alike.
 - D. Mains: **Circuit breaker or Lugs only** as indicated in panelboard schedules.
 - E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: **Bolt-on circuit breakers**.
 - F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: **Bolt-on circuit breakers**.
 - G. Branch Overcurrent Protective Devices (MCCB) frame sizes 200A and larger (or as noted in schedules) shall be electronic trip and shall have adjustable trip settings as indicated in **Section 2.6** below to allow for coordination and limiting of arc flash hazard.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, **provide products by one of the following**:
 - 1. ABB, Formally GE Industrial Solutions
 - 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 3. Square D; a brand of Schneider Electric.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: **Circuit breaker or lugs only** as indicated in panelboard schedules.
- D. Branch Overcurrent Protective Devices: **Bolt-on** circuit breakers, replaceable without disturbing adjacent units.
- E. 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.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, **provide products by one of the following**:
 - 1. ABB, Formally GE Industrial Solutions
 - 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 3. Square D; a brand of Schneider Electric.
- B. 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 element with front mounted, field-adjustable trip setting for circuit-breaker frame sizes 100 A and larger.
 - 2. Electronic Trip Circuit Breakers: **(200A and larger)**
 - a. RMS sensing; field-replaceable rating plug or electronic trip and the following field-adjustable settings:
 - 1) Instantaneous trip.
 - 2) Long- and short-time pickup levels.
 - 3) Long and short time adjustments.
 - 4) Time delay and I²t response.
 - b. Digital display of settings, trip targets, and indicated metering displays.
 - c. Multi-button keypad to access programmable functions and monitored data.
 - d. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
 - e. Integral test jack for connection to portable test set or laptop computer.
 - 3. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
 - 4. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
 - 5. Subfeed Circuit Breakers: Vertically mounted.
 - 6. 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: **Mechanical** 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. Shunt Trip: **120-V** trip coil energized from separate circuit, set to trip at **55** percent of rated voltage.
 - h. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage **without intentional** time delay.
 - i. Rating Plugs: Three-pole breakers with ampere ratings greater than **150** amperes shall have interchangeable rating plugs or electronic adjustable trip units.
 - j. 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.
 - k. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
 - l. Multipole units enclosed in a single housing with a single handle or factory assembled to operate as a single unit.
 - m. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in **on or off** position.
 - n. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

2.6 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: 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.

2.7 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

3.1 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 **NEMA PB 1.1**.
- 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.

3.2 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 **NEMA PB 1.1**.
- D. Equipment Mounting:
 - 1. Attach panelboard to the vertical finished or structural surface behind the panelboard.
- 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** 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 empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch 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.

3.3 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.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. 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.
- D. Panelboards will be considered defective if they do not pass tests and inspections.
- E. 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.

3.5 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.

3.6 PROTECTION

- A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

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. Straight-blade convenience, hospital-grade, isolated-ground, and tamper-resistant receptacles.
 - 2. GFCI receptacles.
 - 3. Twist-locking receptacles.
 - 4. Pendant cord-connector devices.
 - 5. Cord and plug sets.
 - 6. Toggle switches.
 - 7. Decorator-style convenience.
 - 8. Wall plates.
 - 9. Poke-through assemblies.

1.3 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. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

1.4 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.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.6 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.

PART 2 - PRODUCTS

2.1 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.
 - 3. Connectors shall be at right angle. Twist type shall not be permitted.
- 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.

2.2 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.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; Arrowlink 5261-M (single), 5262-M (duplex)
 - b. Pass & Seymour; Plug-Tail 5381 (single), Plug-Tail 5362 (duplex)
 - c. Hubbell; SNAP5361 (single), SNAP5362 (duplex)

2. Provide all receptacles with quick disconnect plug in rear. Plug shall snap in at 90 deg angle.

2.3 GFCI RECEPTACLES

- A. General Description:
 1. 125 V, 20 A, straight blade, **non-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:
 1. Duplex GFCI Convenience Receptacles: Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; Arrowlink VGF20-MOD (duplex)
 - b. Pass & Seymour; Plug-Tail PT2095.
 - c. Hubbell; SNAP GFR5362 (duplex)
 2. Provide all receptacles with quick disconnect plug in rear. Plug shall snap in at 90 deg angle.

2.4 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.

2.5 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.

2.6 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.

2.7 TOGGLE SWITCHES

- A. Comply with NEMA WD 1, UL 20, and FS W-S-896.
 1. Switches not associated with the DLM Lighting system: All Snap switches to be of the quick connect type to have a right angle connector feature with pre-stripped leads. Connector contacts are to be crimped and welded.
- B. Switches, 120/277 V, 20 A:
 1. Products: Basis of design: Pass & Seymour, PT20AC1 (single pole), PT20AC2 (two pole), PT20AC3 (three way), PT20AC4 (four way).
 - a. Subject to compliance with requirements, provide one of the following:
 - 1) Cooper. (Arrowlink Series)
 - 2) Hubbell. (Snapconnect Series)
- C. Pilot-Light Switches: 120/277 V, 20 A.
 1. Products: Basis of design: Pass & Seymour, PT20AC1-SL (single pole), PT20AC3-SL (three way), PT20AC4 (four way).
 - a. Subject to compliance with requirements, provide one of the following:
 - 1) Cooper.
 - 2) Hubbell.
 - 3) Leviton.
 2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

2.8 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: **0.035-inch** thick, satin-finished, Type 302 stainless steel.
 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, **heavy-duty while-in-use** weather-resistant, **die-cast aluminum** with lockable cover.

2.9 POKE-THROUGH ASSEMBLIES

- A. Products: Basis of design as scheduled on drawings.
- B. Description:
 - 1. Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service-outlet assembly.
 - 2. Comply with UL 514 scrub water exclusion requirements.
 - 3. Service-Outlet Assembly: As scheduled on drawings.
 - 4. Size: Selected to fit nominal **4-inch** cored holes (or as noted on drawings) in floor and matched to floor thickness.
 - 5. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
 - 6. Closure Plug: Arranged to close unused **4-inch** cored openings and reestablish fire rating of floor.
 - 7. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of **four**, four-pair cables type as noted on drawings.

2.10 FINISHES

- A. Device Color:
 - 1. Wiring Devices Connected to Normal Power System: **Gray** or **As selected by Architect** unless otherwise indicated or required by NFPA 70 or device listing.
 - 2. Wiring Devices Connected to Emergency Power System: **Red**.
- B. Wall Plate Color: For plastic covers, match device color.

PART 3 - EXECUTION

3.1 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 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**, and on horizontally mounted receptacles to the **right**.
 - 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. Dimmers:
 1. Install dimmers within terms of their listing.
 2. Verify that dimmers used for fan-speed control are listed for that application.
 3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.
 - H. 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.
 - I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.
- 3.2 GFCI RECEPTACLES**
- A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.
- 3.3 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.
- 3.4 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.
 - F. Wiring device will be considered defective if it does not pass tests and inspections.
 - G. Prepare test and inspection reports.

END OF SECTION 262726

SECTION 262813 - 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 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 SKM coordination software and in PDF format**.
 - 5. Coordination charts and tables and related data.

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 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 SKM 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** or more than **100 deg F**, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Bussman, Inc
 - 2. Edison Fuse, Inc.
 - 3. Mersen, formally Ferraz Shawmut, Inc.
 - 4. Little Fuse, Inc.
- B. 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: **600-V**, zero- to 600-A rating, 200 kAIC, **time delay**.
 - 2. Type CC: 600-V, zero- to 30-A rating, 200 kAIC, **fast acting**.
 - 3. Type J: 600-V, zero- to 600-A rating, 200 kAIC, **time delay**.
 - 4. Type L: 600-V, 601- to 6000-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-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. Service Entrance: Class RK1, time delay.
 - 2. Feeders: Class RK1, time delay.
 - 3. Motor Branch Circuits: **Class RK1**, time delay.
 - 4. Large Motor Branch (601-4000 A): Class L, time delay.
 - 5. Power Electronics Circuits: **Class J**, **high speed**.
 - 6. Other Branch Circuits: **Class RK1**, **time delay**.
 - 7. Control Transformer Circuits: Class CC, time delay, control transformer duty.
 - 8. 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 **Owner**.

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 262813

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 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.

1.2 SUMMARY

- A. Section Includes:

1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.4 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. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
 - 5. 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 electronic format compatible with **SKM Software**.
- 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.

1.5 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.

1.6 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 and** electronic format compatible with **SKM Software**.

1.7 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.

1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.9 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 and not exceeding 104 deg F.
 2. Altitude: Not exceeding 6600 feet.

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

2.1 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."

2.2 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.

2.3 FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, **provide products by one of the following**:
1. ABB, Formally GE Industrial Solutions
 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 3. Square D; a brand of Schneider Electric.
- B. Type HD, Heavy Duty:
1. Single throw, Three pole, 600-V ac, 1200 A and smaller.
 2. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate **specified** fuses.
 3. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. 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: **Two** NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - **120-V ac**.
 6. Hookstick Handle: Allows use of a hookstick to operate the handle.
 7. Lugs: **Compression** type, suitable for number, size, and conductor material.
 8. Service-Rated Switches: Labeled for use as service equipment.

2.4 NONFUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, **provide products by one of the following**:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Square D; a brand of Schneider Electric.
- B. Type HD, Heavy Duty, Three Pole, Single Throw, **600-V ac**, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Three Pole, Double Throw, **600-V ac**, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. 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.
 1. Auxiliary Contact Kit: **Two** NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - **120-V ac**.
 2. Hookstick Handle: Allows use of a hookstick to operate the handle.
 3. Lugs: **Compression** type, suitable for number, size, and conductor material.
 4. Service-Rated Switches: Labeled for use as service equipment.

2.5 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

3.1 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.

3.2 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 **Owner** 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 **Owner's** written permission.
 4. Comply with NFPA 70E.

3.3 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. Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 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.

3.4 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.

3.5 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.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. 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."
- C. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- D. 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.

3.7 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 262816

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SECTION 262923 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

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. This Section includes AC motor Variable Frequency Drives rated 600 V and below.

1.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: VFDs 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."

1.4 REFERENCE STANDARDS

- A. NEMA ICS 7.1 – Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable Speed Drive Systems; National Electrical Manufacturers Association.
- B. NEMA ICS 7 – Industrial Control and Systems: Adjustable –Speed Drives; National Electrical Manufacturers Association.
- C. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association.
- D. NFPA 70 – National Electrical Code; National Fire Protection Association.

1.5 SUBMITTALS

- A. See Section 01 3000– Administrative Requirements for submittal procedures.
- B. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.
- C. Shop Drawings: Indicate front and side views of enclosures with overall dimensions and weights shown; conduit entrance locations and requirements; and nameplate legends. Test Reports: Indicate field test and inspection procedures and test results.
- D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Manufacturer's Field Reports: Indicate startup inspection findings.
- F. Operation Data: NEMA ICS 7.1. Include instructions for starting and operating controllers, and describe operating limits that may result in hazardous or unsafe conditions.
- G. Maintenance Data: NEMA ICS 7.1. Include routine preventative maintenance schedule.
- H. Seismic Qualification Certificates: For VFDs, 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.
- I. Product Certificates: For each VFD, from manufacturer.

1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five years documented experience and with service facilities within 200 miles of Project.
- C. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

- B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to components, enclosure, and finish.

1.8 **PROJECT CONDITIONS**

- A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than 14 deg F (minus 10 deg C) and not exceeding 104 deg F (40 deg C).
 - 2. Ambient Storage Temperature: Not less than minus 4 deg F (minus 20 deg C) and not exceeding 140 deg F (60 deg C)
 - 3. Humidity: Less than 95 percent (noncondensing).
 - 4. Altitude: Not exceeding 3300 feet (1005 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 Owner per requirements in the front end documents.
 - 2. Do not proceed with interruption of electrical systems without Owner's written permission.
 - 3. Comply with NFPA 70E.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFDs, including clearances between VFDs, and adjacent surfaces and other items.

1.9 **COORDINATION**

- A. Coordinate features of motors, load characteristics, installed units, and accessory devices to be compatible with the following:
 - 1. Torque, speed, and horsepower requirements of the load.
 - 2. Ratings and characteristics of supply circuit and required control sequence.
 - 3. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 **MANUFACTURED UNITS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Toshiba; Model Q9 Plus or AS3: www.toshiba.com
 - 2. ABB; Model ACH580: www.abb.com
 - 3. Yaskawa; Model HV600 www.yaskawa.com
- B. Manufacturers other than the above are not allowed

2.2 **DESCRIPTION**

- A. Variable Frequency Controllers: Enclosed controllers suitable for operating the indicated loads, in conformance with requirements of NEMA ICS 7. Select unspecified features and options in accordance with NEMA ICS 3.1.
 - 1. Employ microprocessor-based inverter logic isolated from power circuits.
 - 2. Employ pulse-width-modulated inverter system.
 - 3. Include a DC link reactor for reduction of harmonic distortion.
 - 4. The controller, and all associated components, shall be supplied by a single vendor.
 - 5. The controller will be operating a variable volume fan motor, or water pump motor for HVAC application.
 - 6. System voltage shall be indicated on front of ASD, using minimum of 1-inch high letters.
- B. Enclosures: NEMA 250, Type 1, suitable for equipment application in places regularly open to the public. No disconnects in VFD cabinet. Disconnect must be in separate enclosure.

2.3 **OPERATING REQUIREMENTS**

- A. Rated Input Voltage for motors rated below 40 HP: 200 volts, three phase, 60 Hertz, with a voltage tolerance of +/- 10% and a frequency tolerance of +/- 2 Hz.
- B. Rated Output: Output frequency shall vary between 0.1 Hz and 400 Hz. Frequency resolution shall be 0.01 Hz digital and 0.03 Hz analog with an accuracy of +/-0.2% of maximum frequency at 25 degrees Celsius. Maximum voltage frequency shall be adjustable from 25 Hz to 400 Hz. Voltage boost shall be adjustable from 0% to 30% with starting frequency adjustable from 0 Hz to 10 Hz. The output current shall

be 100% continuous and 110% for 60 seconds, based on NEC table 430-250 (Full-Load Current, Three-Phase Alternating Current Motors) for 200 volts or 460 volts.

- C. The controller shall contain three critical frequency jump points with individual bandwidth. Upper and lower frequency limits shall be capable of being varied.
- D. The PWM carrier frequency shall be adjustable from 5000 Hz to 12000 Hz.
- E. The drive shall contain two separate acceleration/deceleration times (0.1 to 6000 seconds) with a choice of linear, S, or C curves. The drive shall have a standard dynamic electric braking for motors rated 30 HP or below. The drive shall restart into a rotating motor by sensing the coasting motor speed and matching that frequency. The drive shall have adjustable soft stall (10%-150%) and adjustable electronic overload protection (10%-100%).
- F. The drive shall have external fault input, be capable of re-setting faults remotely and locally.
- G. Input Signal:
 - 1. 0 to 10 v DC
 - 2. 0 to 5 v DC
 - 3. 4 to 20 mA DC
- H. Manual bypass is not required on VFD unless indicated on bid documents.

2.4 COMPONENTS

- A. Display: Provide integral digital display to indicate output voltage, output frequency, and output current, output power (kw), and motor RPM.

2.5 ENCLOSURES

- A. VFD Enclosures: NEMA 250, to comply with environmental conditions at installed location.
 - 1. Dry and Clean Indoor Locations: Type 1.
 - 2. Outdoor Locations: Type 3R.
 - 3. Other Wet or Damp Indoor Locations: Type 4.
 - 4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.
- B. Disconnects associated with VFD's shall be in separate enclosure from VFD. Disconnect to be installed on the line side of the VFD.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, surfaces, and substrates to receive VFDs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance.
- B. Examine VFD before installation. Reject VFDs that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFD installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install in accordance with NEMA ICS 7.1, manufacturer's instructions, and per drawings.
 - 1. Coordinate layout and installation of VFDs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Wall-Mounting Controllers: Install VFDs on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches (2000 mm) above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."
- C. Seismic Bracing: Comply with requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- D. Tighten accessible connections and mechanical fasteners after placing controller.
- E. The service disconnect switch must be installed on the line side of the VFD. The disconnect must be in a separate enclosure from the VFD. If conditions do not allow this disconnect to be located near the motor within NEC requirements, then a second remote disconnect may be required at the motor. Consult the project manager or University Engineer if this condition arises. All remote disconnects must be provided with auxiliary contacts hardwired to VFD safety circuit to shut down VFD when disconnect is opened. This may affect warranty on the drive so every attempt should be taken to install it per these design guidelines.

- F. If a single VFD is controlling multiple fans in an air handling unit then overload protection on each fan must be provided. No more than 4 fans shall be connected to a single VFD.
- G. The ground wire should be of the same size as the power conductors from the motor to the VFD and from the VFD to the source.
- H. Do not install VFD's on AHU's. Refer to mounting detail on drawings.
- I. For motors larger than 60hp, the installation shall comply with IEEE 519 with the point of common coupling being the VFD feeder supply terminals of the installation. If a harmonic filter is needed for compliance then it shall be installed.

3.3 IDENTIFICATION

- A. Identify VFDs, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each VFD with engraved plastic nameplate.
 - 3. Label each enclosure-mounted control and pilot device.
 - 4. System voltage to be indicated on front of VFD, using minimum 1" high letters.
 - 5. Neatly type label inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating. Place in clear plastic holder.
- B. Operating Instructions: Frame printed operating instructions for VFDs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFD units.

3.4 CONTROL WIRING INSTALLATION

- A. Install wiring between VFDs and remote device. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Bundle, train, and support wiring in enclosures.

3.5 CONNECTIONS

- A. Tighten connectors, terminals, bus joints, and mountings. Tighten field connected connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, comply with tightening torques specified in UL 486A.

3.6 CLEANING

- A. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean devices internally using methods and materials as recommended by manufacturer.

3.7 FIELD QUALITY CONTROL

- A. Prior to initial energizing, provide the service of the manufacturer's field representative to prepare and start controllers.
- B. Perform tests and inspections. Owner shall be provided the opportunity to witness all testing.
 - 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. Pre-testing: On completing installation of the system, perform the following preparations for tests, under the supervision of the factory authorized service representative.
 - a. Clean devices using manufacturer's approved methods and materials.
 - b. Inspect for defects and physical damage, and nameplate compliance with current project drawings.
 - c. Check tightness of electrical connections of devices with calibrated torque wrench. Use manufacturer's recommended torque values.
 - d. Verify proper fuse types and ratings in fusible devices.
 - e. Make insulation resistance tests of conducting parts of motor control components; and of connecting supply, feeder, and control circuits. For devices containing solid-state components, use test equipment and methods recommended by the manufacturer.
 - f. Make continuity tests of circuits.

- g. Exercise and perform operational tests of mechanical components and other operable devices in accordance with manufacturer's instructions.
 - 1) Visual and mechanical inspection: Include the following inspections and related work.
 - h. Motor-Control Device Ratings and Settings: Verify that ratings and settings as installed are appropriate for final loads and final system arrangement and parameters as recommended by Division 15. Recommend final protective-device ratings and settings where differences are found. Use accepted revised ratings or settings to make the final system adjustments. Prepare and submit the load current and overload relay heater list.
- D. Electrical Tests: Perform the following in accordance with manufacturer's instructions:
 - 1. Insulation resistance test of motor control devices conducting parts to the extent permitted by the manufacturer's instructions. Insulation resistance less than recommended by the manufacturer are unacceptable.
 - a. Make adjustments for final settings of adjustable-trip devices.
 - b. Test auxiliary protective features such as loss of phase, lockout, phase unbalance and undervoltage to verify operation.
 - c. Check for improper voltages at terminals in Drives that have external control wiring when controller disconnect is opened. Any voltage over 30 V is unacceptable.
- E. Correct deficiencies and retest motor control devices. Verify by the system tests that specified requirements are met.
- F. Labeling: On satisfactory completion of tests and related effort, apply a label to tested components indicating test results, date, and responsible organization and person.

3.8 MAINTENANCE

- A. Furnish two extra of each air filter.
- B. Provide service and maintenance of controllers for one year from date of Substantial Completion.
- C. General Requirements: Provide, at no additional cost to the Owner, all services, materials and equipment necessary for the successful operation of the entire system for a period of one year from Date of Substantial completion. Provide necessary material required for the work. Minimize impacts on facility operations when performing scheduled adjustments and non-scheduled work.
- D. Description of Work: The adjustment and repair of the system includes all computer equipment, software updates, electronic and electrical components, equipment and all sensors and control devices. Provide the manufacturer's required adjustments and all other work necessary.
- E. Personnel: Provide qualified personnel to accomplish all work promptly and satisfactorily. Owner shall be advised in writing of the name of the designated service representative, and of any changes in personnel.
- F. Emergency Service: Owner will initiate service calls when a Variable Frequency Drive is not functioning properly. Qualified personnel shall be available to provide service of the complete system, including external controls. Furnish owner with a telephone number where service representative can be reached at all times. Service personnel shall be at the site within 24 hours after receiving a request for service. Restore the Variable Frequency Drive system to proper operating condition within 3 days.
- G. Operating: Performance of scheduled adjustments and repair shall verify operation of the system as demonstrated by the initial performance test.
- H. Systems Modifications: Provide all recommendations for system modification in writing to Owner. Do not make any system modifications, including operating parameters and control settings, without prior approval of Owner. All modifications made to the system shall be incorporated into the operations and maintenance manuals, and other documentation affected.

3.9 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFDs.

END OF SECTION 262923

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SECTION 26 51 19 - LED INTERIOR LIGHTING

PART 1 - PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes LED luminaires:

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IC: Insulation Contact
- E. IECC: International Energy Conservation Code
- F. IP: International Protection or Ingress Protection Rating.
- G. LED: Light-emitting diode.
- H. Lumen: Measured output of lamp and luminaire, or both.
- I. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 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. 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.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing laboratory providing photometric data for luminaires.
- B. 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.
- C. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Product Certificates: For each type of luminaire.
- E. Product Test Reports: For each luminaire, for tests performed by **manufacturer and witnessed by a qualified testing agency**.
- F. Sample warranty.

1.6 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.

1.7 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. Diffusers and Lenses: **One for every 100** of each type and rating installed. Furnish at least one of each type.
2. Globes and Guards: **One for every 20** of each type and rating installed. Furnish at least one of each type.

1.8 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. Provide luminaires from a single manufacturer for each luminaire type.
- C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Manufacturer shall protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.
- B. Store all materials in the manufacturer's original packaging until ready for installation. Protect all products from damage or exposure to adverse environmental conditions, including weather, humidity, and dust.

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

2.1 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."

2.2 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. UL Listing: Listed for damp location.
 2. Recessed luminaires shall comply with NEMA LE 4. Additionally, recessed light fixtures located in the building thermal envelope shall be IC rated and tested and labeled that they meet the energy code Air Leakage requirements of ASTM E283.
 3. User Replaceable Lamps:
 - a. Bulb shape complying with ANSI C78.79.
 - b. Lamp base complying with **ANSI C81.61 or IEC 60061-1**.
- C. CRI of minimum 80. CCT of 3500 K (Unless specifically noted in luminaire and lamp schedules).
- D. Rated lamp life of **50,000** hours to L70.
- E. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- F. Internal driver.
- G. Nominal Operating Voltage: **as noted on the drawings**.
 1. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
- H. Housings:
 1. **Extruded-aluminum** housing and heat sink.
 2. **powder-coat painted** finish or as noted in Luminaire Schedule.

2.3 LUMINAIRE TYPES

- A. Refer to Luminaire Schedule on the Drawings for each Luminaire Type.
 1. Contractor may submit substitution request for equal products to those listed in the Luminaire schedule prior to bid for evaluation. If approved, formal approval will be issued. No substitutions will be entertained and/or permitted after bid date.

2.4 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. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
- D. 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.

2.5 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.

2.6 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 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**.
- D. Rod Hangers: 3/16-inch 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

3.1 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.

3.2 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. Begin installation only after spaces are enclosed and weather-tight, and after all wet work and overhead work has been completed.
- E. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer. Do not install products under environmental conditions outside manufacturer's recommended limits.
- F. Protect finishes from dust and damage during installation.
 - 1. Protective coverings shall not be removed until the room/space has been cleaned of debris/dust and all finish work that may generate dust or debris has been completed.
- G. 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.
- H. 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.
- I. Wall-Mounted Luminaire Support:

1. Attached to a minimum 20 gauge backing plate attached to wall structural members.
2. Do not attach luminaires directly to gypsum board.
- J. Suspended Luminaire Support:
 1. Pendants and Rods: Where longer than 48 inches, 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.
- K. 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.
- L. Recessed Luminaires: Contractor shall seal with a gasket or caulk between the light fixture housing and interior wall or ceiling covering for all recessed light fixtures located in the building thermal envelope.
- M. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 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.
- D. Remove any dust and debris from light fixtures according to manufacturer's recommendations.
- E. Damaged or defective products shall be repaired or replaced prior to substantial completion.

3.5 ADJUSTING

- A. Occupancy Adjustments: When requested within **12** months of date of Substantial Completion, provide on-site assistance in adjusting the control of luminaires to suit occupied conditions. Make up to **two** visits to Project during other-than-normal hours for this purpose.
 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 luminaire mounted motion sensors as required.

END OF SECTION 26 51 19

SECTION 265219 - EMERGENCY AND EXIT LIGHTING

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. Emergency lighting units.
 - 2. Exit signs.
 - 3. Luminaire supports.

1.3 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.

1.4 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. 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. Product Schedule:
 - 1. For emergency lighting units. Use same designations indicated on Drawings.
 - 2. For exit signs. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing laboratory providing photometric data for luminaires.
- B. Product Certificates: For each type of luminaire.
- C. 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.
- D. Product Test Reports: For each luminaire for tests performed by **manufacturer and witnessed by a qualified testing agency**.
- E. Sample Warranty: For manufacturer's **special** warranty.

1.6 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.

1.7 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.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.9 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: Five 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: **Five** years from date of Substantial Completion. Full warranty shall apply for **the entire warranty period**.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to **ASCE/SEI 7 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."

2.2 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 or IEC 60061-1**.
- G. Bulb Shape: Complying with ANSI C79.1.

2.3 EMERGENCY LIGHTING

- A. Refer to Luminaire Schedule on the Drawings for each Luminaire Type.
 - 1. Contractor may submit substitution request for equal products to those listed in the Luminaire schedule prior to bid for evaluation. If approved, formal approval will be issued. No substitutions will be entertained and/or permitted after bid date.
- B. General Requirements for Emergency Lighting Units: Self-contained units.
- C. Emergency Lighting Unit:
 - 1. **Wall** with universal junction box adaptor.
 - 2. UV stable thermoplastic housing, **rated for damp locations**.
 - 3. **Two LED** lamp heads.
 - 4. **Internal** emergency power unit.
 - 5. Self-Diagnostics
- D. Remote Emergency Lighting Units:
 - 1. **Wall** with universal junction box adaptor.
 - 2. UV stable thermoplastic housing, **rated for damp locations**.
 - 3. **Two LED** lamp heads.
 - 4. External emergency power unit.

2.4 EXIT SIGNS

- A. Refer to Luminaire Schedule on the Drawings for each Luminaire Type.
 - 1. Contractor may submit substitution request for equal products to those listed in the Luminaire schedule prior to bid for evaluation. If approved, formal approval will be issued. No substitutions will be entertained and/or permitted after bid date.
- B. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

1. Lamps for AC Operation: LEDs; 50,000 hours minimum rated lamp life.
2. Self-Powered Exit Signs (Battery Type): Internal emergency power unit.
3. Master/Remote Sign Configurations:
 - a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in **LED power supply battery** for power connection to remote unit.
 - b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery, and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.
4. Self-Diagnostics

2.5 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. Clear, UV-stabilized acrylic.
 2. Acrylic: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
- D. Conduit: **Electrical metallic tubing**, minimum 3/4 inch in diameter.

2.6 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.

2.7 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**.

PART 3 - EXECUTION

3.1 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.

3.2 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. Begin installation only after spaces are enclosed and weather-tight, and after all wet work and overhead work has been completed.
- E. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer. Do not install products under environmental conditions outside manufacturer's recommended limits.
- F. Protect finishes from dust and damage during installation.
 1. Protective coverings shall not be removed until the room/space has been cleaned of debris/dust and all finish work that may generate dust or debris has been completed.
- G. 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.
- H. Wall-Mounted Luminaire Support:
 1. Attached to a minimum 20-gage backing plate attached to wall structural members.
 2. Do not attach luminaires directly to gypsum board.
- I. Suspended Luminaire Support:
 1. Pendants and Rods: Where longer than 48 inches, 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.
- J. 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.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 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.
- D. Remove any dust and debris from luminaires according to manufacturer's recommendations.
- E. Damaged or defective products shall be repaired or replaced prior to substantial completion.

3.5 STARTUP SERVICE

- A. Perform startup service:
 1. Charge **emergency power units and batteries** minimum of 24 hours and conduct one-hour discharge test.

3.6 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 265219

SECTION 270500 - COMMON WORK RESULTS FOR COMMUNICATIONS

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. Communications equipment coordination and installation.
 - 2. Common communications installation requirements.

1.3 COORDINATION

- A. Coordinate arrangement, mounting, and support of communications equipment:
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping and conduit installed at required slope.
 - 4. All connecting pathways, cables, wireways, cable trays, and busways shall be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."
- E. Coordinate sleeve selection and application and installation as specified in Division 27 Section "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

PART 2 - PRODUCTS

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR COMMUNICATIONS INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both communications equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Install sleeves as specified in Division 27 Section "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.3 SLEEVE-SEAL INSTALLATION

- A. Install sleeve-seals as specified in Division 27 Section "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.4 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 270500

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SECTION 270544 - SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS 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 pathway and cable penetration of non-fire-rated construction walls and floors.
 - 2. Sleeve-seal systems.
 - 3. Sleeve-seal fittings.
 - 4. Grout.
- B. Related Requirements:
 - 1. Division 07 Section "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 minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
 - 1. Use EZ-PATH Smoke and Acoustical Pathways (or pre-approved equal)
- C. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- D. Sleeves for Rectangular Openings:
 - 1. Material: Galvanized-steel sheet.
 - 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.
 - 1. Manufacturers: Subject to compliance with requirements, **provide products by the following:**
 - a. Advance Products & Systems, Inc.
 - b. CALPICO, Inc.
 - c. Metraflex Company (The).
 - d. Pipeline Seal and Insulator, Inc.
 - e. Proco Products, Inc.
 - 2. Sealing Elements: **EPDM** rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 3. Pressure Plates: **Carbon steel**.
 - 4. 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.
 - 1. Manufacturers: Subject to compliance with requirements, **provide products by the following:**
 - a. Presealed Systems.

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, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

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 pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "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** annular clear space between sleeve and pathway 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** above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
 - 1. Where noted on drawings, use the EZ-Path smoke and acoustical pathways. (Or pre-approved equal)
 - 2. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual pathways 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 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 annular clear space between pathway 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 pathway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway 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 270544

SECTION 283111 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

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. Manual fire-alarm boxes.
 - 2. System smoke detectors.
 - 3. Heat detectors.
 - 4. Notification appliances.
 - 5. Magnetic door holders.
 - 6. Addressable interface device.

1.3 DEFINITIONS

- A. LED: Light-emitting diode.
- B. NICET: National Institute for Certification in Engineering Technologies.

1.4 SYSTEM DESCRIPTION

- A. The existing fire alarm system is a Honeywell E3 series Addressable panel. The intent of this specification is to provide voice notification devices compatible with the existing fire alarm system.
 - 1. Existing devices consist of Horn/Strobe notification. All new devices to be Speaker/Strobe or Speakers as indicated on drawings. Supplemental voice control panels for new devices to be provided as indicated on drawings to be tied into the existing Fire Alarm control panel for a fully functional system.

1.5 SUBMITTALS

- A. General Submittal Requirements:
 - 1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
 - 2. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire-alarm system design.
 - b. NICET-certified fire-alarm technician, **Level IV** minimum.
 - c. Licensed or certified by authorities having jurisdiction.
- B. Product Data: For each type of product indicated.
- C. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
 - 2. Provide design calculation showing current draw on each notification circuit with allowance for minimum of **20% expansion**.
 - 3. Include voltage drop calculations for notification appliance circuits.
 - 4. Include battery-size calculations and show that they are sized a minimum of **125%** of calculated requirement.
 - a. Show supervisory power requirements for all equipment
 - b. Show alarm power requirements for all equipment
 - c. Show power supply rating justification showing power requirements for each of the system power supplies. Power supplies shall be sized to furnish the total connected load in a worst case condition.
 - 5. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
 - 6. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
 - 7. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
 - 8. Indicate wattage and speaker tap settings for each speaker in plan.
 - 9. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

10. Complete riser diagram including devices with associated tags/room no. and circuits.
- D. Qualification Data: For qualified Installer.
- E. Field quality-control reports.
- F. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
 2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
 3. Record copy of site-specific software.
 4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
 - a. Frequency of testing of installed components.
 - b. Frequency of inspection of installed components.
 - c. Requirements and recommendations related to results of maintenance.
 - d. Manufacturer's user training manuals.
 5. Manufacturer's required maintenance related to system warranty requirements.
 6. Abbreviated operating instructions for mounting at fire-alarm control unit.
 7. Copy of NFPA 25.
- G. Software and Firmware Operational Documentation:
 1. Software operating and upgrade manuals.
 2. Program Software Backup: On magnetic media or compact disk, complete with data files.
 3. Device address list.
 4. Printout of software application and graphic screens.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm **Level II** technician.
- 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. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Existing Fire alarm system is E3 Series as manufactured by Gamewell-FCI; a Honeywell company. Provide devices compatible with existing system.

2.2 SYSTEMS OPERATIONAL DESCRIPTION (Existing System)

- A. *Fire-alarm signal initiation shall be by one or more of the following devices **and systems**:*
 1. *Manual stations.*
 2. *Heat detectors.*
 3. *Smoke detectors.*
 4. *Verified automatic alarm operation of smoke detectors.*
 5. *Automatic sprinkler system water flow.*
 6. *Heat detectors in elevator shaft and pit.*
 7. *Fire-extinguishing system operation.*
 8. *Fire standpipe system.*
- B. *Fire-alarm signal shall initiate the following actions:*
 1. *Continuously operate alarm notification appliances.*
 2. *Identify alarm at fire-alarm control unit **and remote annunciators**.*
 3. *Transmit an alarm signal to the remote alarm receiving station.*
 4. *Unlock electric door locks in designated egress paths.*
 5. *Release fire and smoke doors held open by magnetic door holders.*
 6. *Activate voice/alarm communication system.*
 7. *Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.*
 8. *Close smoke dampers in air ducts of designated air-conditioning duct systems.*
 9. *Recall elevators to primary or alternate recall floors.*
 10. *Activate emergency shutoffs for gas and fuel supplies.*
 11. *Record events in the system memory.*
 12. *Record events by the system printer.*
- C. *Supervisory signal initiation shall be by one or more of the following devices and actions:*

1. Valve supervisory switch.
 2. Low-air-pressure switch of a dry-pipe sprinkler system.
 3. Fire-pump power failure, including a dead-phase or phase-reversal condition.
 4. Elevator shunt-trip supervision.
 5. Duct smoke detectors
- D. System trouble signal initiation shall be by one or more of the following devices and actions:
1. Open circuits, shorts, and grounds in designated circuits.
 2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
 3. Loss of primary power at fire-alarm control unit.
 4. Ground or a single break in fire-alarm control unit internal circuits.
 5. Abnormal ac voltage at fire-alarm control unit.
 6. Break in standby battery circuitry.
 7. Failure of battery charging.
 8. Abnormal position of any switch at fire-alarm control unit or annunciator.
 9. Low-air-pressure switch operation on a dry-pipe or preaction sprinkler system.
- E. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit **and remote annunciators**. Record the event on system printer.
1. **Fire alarm panel shall provide trouble and alarm outputs to building BAS system. (Energy Management Controls System)**

2.3 FIRE-ALARM CONTROL UNIT (Existing to remain)

- A. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, **supervisory and digital alarm communicator transmitters** shall be powered by 24-V dc source.
1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
 2. Provide additional power supply modules as required to accommodate new devices.
- B. Notification Appliance Circuit: Operation shall sound in a programmable wav file to simulate the Horn tone for all new speakers. Minimum one loop/circuit per floor.
1. Minimum of 1.5 amps per circuits at 24vdc.
- C. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke barrier walls shall be connected to fire-alarm system.
- D. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided as a special module that is part of fire-alarm control unit.
1. Indicated number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711 and be listed by an NRTL.
 - a. Allow the application of and evacuation signal to indicated number of zones and, at same time, allow voice paging to the other zones selectively or in any combination.
 - b. Programmable tone and message sequence selection.
 - c. Standard digitally recorded messages for "Evacuation" and "All Clear."
 - d. Provide custom messages as requested by owner for "Storm" and "Lockdown" to be initiated manually at main fire alarm control panel and annunciator panel.
 - e. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification appliance circuits of fire-alarm control unit.
 2. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.
 3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.
- E. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.
1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

2.4 MANUAL FIRE-ALARM BOXES

- A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
1. Double-action mechanism requiring two actions to initiate an alarm, **pull-lever** type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
 2. Station Reset: Key- or wrench-operated switch.

2.5 SYSTEM SMOKE DETECTORS

- A. General Requirements for System Smoke Detectors:
1. Comply with UL 268; operating at 24-V dc, nominal.
 2. Detectors shall be **two-wire** type.
 3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
 4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 5. Integral Visual-Indicating Light: LED type indicating detector has operated **and power-on status**.
 6. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
 - a. Rate-of-rise temperature characteristic shall be selectable at fire-alarm control unit for 15 or 20 deg F per minute.
 - b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F.
 - c. Provide multiple levels of detection sensitivity for each sensor.
- B. Photoelectric Smoke Detectors:
1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).
- C. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).
 3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
 4. Each sensor shall have multiple levels of detection sensitivity.
 5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
 6. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.
 7. Provide with remote test station located near duct detector in an accessible location. Label indicating which detector it is controlling.

2.6 HEAT DETECTORS

- A. General Requirements for Heat Detectors: Comply with UL 521.
- B. Heat Detector, Combination Type: Actuated by either a fixed temperature of **135 deg F** or a rate of rise that exceeds **15 deg F** per minute unless otherwise indicated.
1. Mounting: **Twist-lock base interchangeable with smoke-detector bases**.

2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
- C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of **190 deg F**.
 1. Mounting: **Twist-lock base interchangeable with smoke-detector bases.**
 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.7 NOTIFICATION APPLIANCES

- A. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated and with screw terminals for system connections.
 1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.
- B. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 85 dBA, measured 10 feet (3 m) from the horn, using the coded signal prescribed in UL 464 test protocol.
 1. Horns shall be Wheelock NH or AH series or equal.
 2. **Provide only where specifically shown on drawings.**
- C. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch high letters on the lens.
 1. Rated Light Output:
 - a. 15/30/75/110 cd, selectable in the field.
 2. Mounting: Wall mounted unless otherwise indicated.
 3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
 4. Flashing shall be in a temporal pattern, synchronized with other units.
 5. Strobe Leads: Factory connected to screw terminals.
 6. Mounting Faceplate: Factory finished, **white**.
 7. Strobes shall be Wheelock RSS series with Wheelock SM, DSM synchronization control module or equal.
- D. Voice/Tone Notification Appliances:
 1. Appliances shall comply with UL 1480 and shall be listed and labeled by an NRTL.
 2. High-Range Units: Rated 2 to 15 W.
 3. Low-Range Units: Rated 1 to 2 W.
 4. Mounting: **semirecessed**.
 5. Matching Transformers: Tap range matched to acoustical environment of speaker location.
 6. Speakers shall be Wheelock series ET or equal.

2.8 MAGNETIC DOOR HOLDERS

- A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
 1. Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.
 2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
 3. Rating: 24-V ac or dc.
- B. Material and Finish: Match door hardware.

2.9 ADDRESSABLE INTERFACE DEVICE

- A. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.
- B. Integral Relay: Capable of providing a direct signal **to elevator controller to initiate elevator recall**.

2.10 DIGITAL ALARM COMMUNICATOR TRANSMITTER (Existing to remain)

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72 for installation of fire-alarm equipment.
- B. Equipment Mounting: Install fire-alarm control unit on finished floor with tops of cabinets not more than 72 inches above the finished floor.
 1. Comply with requirements for seismic-restraint devices specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- C. Smoke- or Heat-Detector Spacing:
 1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.

2. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.
3. Smooth ceiling spacing shall not exceed **30 feet**.
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A in NFPA 72.
5. HVAC: Locate detectors not closer than **3 feet** from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture.
- D. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.
- E. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.
- F. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.
- G. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.
- H. Visible Alarm-Indicating Devices: Install adjacent to each alarm speaker and at least 6 inches below the ceiling.
- I. Device Location-Indicating Lights: Locate in public space near the device they monitor.
- J. All fire alarm wiring shall be run in conduit tight to structure. No conduit runs shall run across structural pans. Mount it tight to bottom of joists/beams. Junction boxes and covers to be red.

3.2 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08 Section "Door Hardware." Connect hardware and devices to fire-alarm system.
 1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
 1. Smoke dampers in air ducts of designated air-conditioning duct systems.
 2. Alarm-initiating connection to elevator recall system and components.
 3. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
 4. Supervisory connections at valve supervisory switches.
 5. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
 6. Supervisory connections at elevator shunt trip breaker.
 7. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
 8. Supervisory connections at fire-pump engine control panel.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- B. Install framed instructions in a location visible from fire-alarm control unit.

3.4 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

3.5 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by **authorities having jurisdiction**.
- 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. Tests and Inspections:
 1. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.

- b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
 - 2. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
 - 3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
 - 4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
 - 5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
 - 6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
 - E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
 - F. Fire-alarm system will be considered defective if it does not pass tests and inspections.
 - G. Prepare test and inspection reports.
 - H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
 - I. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.
- 3.6 DEMONSTRATION**
- A. **Engage a factory-authorized service representative to train** Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 283111

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