

PROJECT MANUAL FOR: PATIENT CARE TOWER—T1230 MRI ROOM
PROJECT NUMBER: CP245321 (OWH PROJECT NO. 2498000)

AT
UNIVERSITY OF MISSOURI - COLUMBIA
COLUMBIA, MISSOURI

FOR:

THE CURATORS OF THE UNIVERSITY OF MISSOURI

PREPARED BY:

OWH
222 S. Bemiston Ave., Suite 200
St. Louis, Missouri 63105

Introba, Inc.
6 South Old Orchard
St. Louis, MO 63119

DATE: July 9, 2024

PROJECT MANUAL FOR: PATIENT CARE TOWER – T1230 MRI ROOM

PROJECT NUMBER: CP245321

AT
UNIVERSITY OF MISSOURI - COLUMBIA
COLUMBIA, MISSOURI

FOR:

THE CURATORS OF THE UNIVERSITY OF MISSOURI

PREPARED BY:

OWH, INC.
RICK J. OTTOLINO, AIA
222 S. BEMISTON AVE., SUITE 200
CLAYTON, MO 63105
PH: (314) 721-4050
FAX: (314) 721-6632



DATE: July 9, 2024

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.

Signature: _____

PROJECT MANUAL FOR: PATIENT CARE TOWER – T1230 MRI ROOM

PROJECT NUMBER: CP245321

AT
UNIVERSITY OF MISSOURI - COLUMBIA
COLUMBIA, MISSOURI

FOR:

THE CURATORS OF THE UNIVERSITY OF MISSOURI

PREPARED BY:

INTROBA, INC.
MARK SCHAEFER
6 SOUTH OLD ORCHARD
ST. LOUIS, MO 63119
PH: (314) 918-8383
FAX: (314) 918-1766



DATE: July 9, 2024

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.

Signature: 

PROJECT MANUAL FOR: PATIENT CARE TOWER – T1230 MRI ROOM

PROJECT NUMBER: CP245321

AT
UNIVERSITY OF MISSOURI - COLUMBIA
COLUMBIA, MISSOURI

FOR:

THE CURATORS OF THE UNIVERSITY OF MISSOURI

PREPARED BY:

INTROBA, INC.
BRUCE LEE
6 SOUTH OLD ORCHARD
ST. LOUIS, MO 63119
PH: (314) 918-8383
FAX: (314) 918-1766

DATE: July 9, 2024

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.

Signature: 



CAMPUS FACILITIES

General Services Bldg.
Columbia, Missouri 65211
Telephone: (573) 882-6800

ADVERTISEMENT FOR BIDS

Sealed bids for:

PATIENT CARE TOWER –
T1230 MRI ROOM
UNIVERSITY OF MISSOURI
COLUMBIA, MISSOURI

PROJECT NUMBER: CP245321

CONSTRUCTION ESTIMATE \$1,370,250 - \$1,522,500

will be received by the Curators of the University of Missouri, Owner, at Campus Facilities, Planning, Design & Construction, Room L100 (Front Reception Desk), General Services Building, University of Missouri, Columbia, Missouri 65211, until 1:30 p.m., C.T., August 27, 2024 and then immediately opened and publicly read aloud.

Bids will be accepted from Prequalified Health Care General Contractors **only**. A list of Prequalified Health Care General Contractors may be obtained at <http://operations-webapps.missouri.edu/pdc/adsite/ad.html>.

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 Rick Ottolino with Ottolino Winters Huebner at (314) 721-4050 or rick.ottolino@owh-inc.com. Questions regarding commercial conditions should be directed to Ben Myers at (573) 884-8458 or bmyers@missouri.edu.

A prebid meeting will be held at 10:00 a.m., C.T., August 14, 2024 in Room 194B General Services Building followed by a site walk-through. All interested bidders are invited to attend this meeting.

Information regarding bid results will be available the day following the bid opening by calling (573) 882-1133

A Diversity Participation goal of 10% MBE, 10% Combined WBE, DBE, Veteran Owned Business 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) 882-1133.

Advertisement Date: July 25, 2024

PROJECT MANUAL FOR: Patient Care Tower – T1230 MRI Room

PROJECT NUMBER: CP245321

TABLE OF CONTENTS

<u>TITLE</u>	<u>PAGE</u>
<u>DIVISION 1</u>	<u>GENERAL REQUIREMENTS</u>
	Advertisement for Bids
1.A	Bid for Lump Sum Contract 1.A 1-5
1.B	Bidder's Statement of Qualifications BSQ/1-2
1.B.2	Supplier Diversity Compliance Evaluation SD 1-2
1.B.3	Application for Waiver SD 3-4
1.B.4	Affidavit for Affirmative Action SD 5-6
1.B.5	Certifying Supplier Diversity Agencies SD 7
1.B.6	Newspapers for Outreach to Diverse Suppliers SD 8
1.B.7	Affidavit of Supplier Diversity Participation SD 9
1.C	Information for Bidders IFB/1-7
1.D	General Conditions GC/1-39
1.E	Special Conditions SC 1-SC-17
1.E.1	Scheduling Specification SS 1- 3
1.E.2	Roofing System Manufacturer's Certification RSMC1
1.E.3	Contractor's Roofing/Flashing/Sheet Metal Guarantee CRFSMG 1-2
1.E.4	Shop Drawing and Submittal Log SDSL 1-11
1.E.5	Operating Instructions and Service Manual Log OMML 1-2
1.E.6	Closeout Log CLOSL 1-3
1.E.7	Quality Assurance Log COM 1-14
1.F	Index of Drawings INDEX 1-2
1.G	Prevailing Wage Rates PW 1-5
1.H	Healthcare Construction Guidelines HCG 1-21

<u>DIVISION 1</u>	<u>GENERAL REQUIREMENTS</u>
01 0500	Field Engineering
01 3150	Coordination Drawings
<u>DIVISION 2</u>	<u>SITE WORK</u>
02 4116	Demolition for Remodeling
<u>DIVISION 3</u>	<u>CONCRETE</u>
03 5400	Cast Underlayment
<u>DIVISION 4</u>	<u>MASONRY (NOT USED)</u>
<u>DIVISION 5</u>	<u>METALS</u>
05 4000	Cold Formed Metal Framing
05 5000	Metal Fabrications
<u>DIVISION 6</u>	<u>WOOD AND PLASTICS</u>
06 1000	Rough Carpentry
06 2000	Finish Carpentry
06 4130	custom Plastic Laminate Casework
<u>DIVISION 7</u>	<u>THERMAL AND MOISTURE PROTECTION</u>
07 5300	Elastomeric Membrane Roofing
07 6200	Sheet Metal Flashing and Trim
07 8400	Firestopping
07 9200	Joint Sealants
<u>DIVISION 8</u>	<u>DOORS, WINDOWS & GLASS</u>
08 1113	Hollow Metal Doors and Frames
08 1416	Flush Wood Doors
08 3100	Access Doors and Panels
08 4229	Automatic Entrances
08 4229.23	Sliding Automatic Entrances
08 7100	Door Hardware
08 8000	Glazing
<u>DIVISION 9</u>	<u>FINISHES</u>
09 2116	Gypsum Board Assemblies
09 2216	Non-Structural Metal Framing
09 3000	Tiling
09 5100	Acoustical Ceilings
09 5300	Acoustical Insulation
09 6500	Resilient Flooring
09 6813	Carpet Tile
09 9123	Interior Painting

<u>DIVISION 10</u>	<u>SPECIALTIES</u>
10 2123	Cubicle Curtain, Track, and Hardware
10 2601	Wall and Corner Guards
10 2800	Toilet Accessories
10 4400	Fire Protection Specialties
10 9990	Miscellaneous Specialties
<u>DIVISION 11</u>	<u>EQUIPMENT</u>
11 5000	Equipment Responsibility
<u>DIVISION 12</u>	<u>FURNISHINGS (NOT USED)</u>
<u>DIVISION 13</u>	<u>SPECIAL CONSTRUCTION</u>
13 4906	MRI – Magnetic Shielding
13 4942	Radio Frequency Shielded Enclosures
<u>DIVISION 14</u>	<u>CONVEYING SYSTEMS (NOT USED)</u>
<u>DIVISION 15</u>	<u>MECHANICAL (NOT USED)</u>
<u>DIVISION 16</u>	<u>ELECTRICAL (NOT USED)</u>
<u>DIVISION 20</u>	<u>MECHANICAL SUPPORT</u>
20 0800	Seismic Protection
<u>DIVISION 21</u>	<u>FIRE PROTECTION</u>
21 0100	Basic Fire Protection Requirements
21 0500	Common Work Results for Fire Suppression
21 1313	Wet-Pipe Sprinkler Systems – FP Updates All Changed Tracked
<u>DIVISION 22</u>	<u>PLUMBING</u>
22 0100	Basic Plumbing Requirements
22 0500	Basic Plumbing Materials and Methods
22 0523	Valves
22 0529	Hanger and Supports for Plumbing Piping and Equipment
22 0700	Plumbing Insulation
22 1116	Domestic Water Piping
22 1119	Domestic Water Piping Specialties
22 1316	Sanitary Waste and Vent Piping
22 1319	Sanitary Waste Piping Specialties
22 1413	Storm Drainage
22 4300	Plumbing Fixtures
22 6113	Compressed-Air Piping for Laboratory and Healthcare Facilities
22 6213	Vacuum Piping for Laboratory and Healthcare Facilities
22 6313	Gas Piping for Laboratory and Healthcare Facilities
<u>DIVISION 23</u>	<u>MECHANICAL</u>
23 0100	Basic Mechanical Requirements
23 0500	Basic Mechanical Materials and Methods

23 0513	Motors
23 0519	Meters and Gages
23 0523	Valves
23 0529	Hangers and Supports
23 0548	Vibration and Seismic Controls for HVAC
23 0594	Testing, Adjusting, and Balancing
23 0700	Mechanical Insulation
23 0900	HVAC Instrumentation and Controls
23 2113	Hydronic Piping
23 2213	Steam and Condensate Piping
23 3113	Metal Ducts
23 3000	Duct Accessories
23 3600	Air Terminal Units
23 3713	Diffusers, Registers and Grilles
23 8123	Computer-Room Air-Conditioning Systems
23 8413	Humidifiers

DIVISION 26

ELECTRICAL

26 0500	Common Work Results for Electrical
26 0519	Conductors and Cables
26 0526	Grounding and Bonding
26 0529	Hangers and Supports
26 0533	Raceways
26 0534	Boxes, Cabinets and Enclosures
26 0536	Cable Trays
26 0553	Identification for Electrical Systems
26 0573	Power System Studies
26 0600	Electrical Demolition
26 0923	Lighting Control Devices
26 2416	Panelboards
26 2726	Wiring Devices
26 2813	Fuses
26 2816	Enclosed Switches
26 5100	LED Lighting

DIVISION 28

ELECTRONIC SAFETY AND SECURITY

28 3111	Digital, Addressable Fire-Alarm System
---------	--

END OF SECTION

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 Corporation(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 OWH, Inc., entitled "Patient Care Tower – T1230 MRI Room", project number CP245321, dated July 8, 2024 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 proposes 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 following addenda:

Addendum No. _____ Dated _____

Addendum No. _____ Dated _____

2. In following Bid(s), amount(s) shall be written in both words and figures. In case of discrepancy between words and figures, words shall govern.

3. **BID PRICING**

a. Base Bid:

The Bidder agrees to furnish all labor, materials, tools, and equipment required to complete the work as summarized in the Special Conditions, 3 Scope of Work; all as indicated on the Drawings and described in these Specifications for 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 One Hundred and Eighty Two (182) calendar days from receipt of aforementioned documents. Fifteen (15) calendar days have been allocated in construction schedule for receiving aforementioned documents 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 Owner receives properly prepared and executed Contract documents listed in paragraph 4.a. above.

d. Special scheduling requirements: Work to be complete by May 30, 2025

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, State
Mechanical	_____	
Electrical	_____	

6. SUPPLIER DIVERSITY PARTICIPATION GOALS

a. The Contractor shall have as a goal, subcontracting with Minority Business Enterprise (MBE) of 10%, with Service Disabled Veteran Owned Business (SDVE) of 3%, with Women Business Enterprise (WBE) of 10%, Disadvantage Business Enterprise (DBE), and/or Veteran Owned Business of Ten Percent (10%) of awarded contract price for work to be performed.

b. Requests for waiver of this goal shall be submitted on the attached Application For Waiver form. A determination by the UM Executive Director of Facilities Planning & Development, that a good faith effort has not been made by Contractor to achieve above stated goal may result in rejection of bid.

c. The Undersigned proposes to perform work with following Supplier Diversity participation level:

MBE PERCENTAGE PARTICIPATION: _____ percent (_____%)
SDVE PERCENTAGE PARTICIPATION: _____ percent (_____%)
WBE, DBE, and/or VETERAN PERCENTAGE PARTICIPATION: _____ percent (_____%)

d. 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 ACKNOWLEDGMENTS

- 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 of 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."

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.	Federal Employer ID 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 Serviced 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/slcdc/

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.slmbc.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: _____

University of Missouri
INFORMATION FOR BIDDERS

	Page No.
1. Contract Documents and Definitions.....	IFB/1
2. Bidder’s Obligation	IFB/1
3. Interpretation of Documents.....	IFB/1
4. Bids.....	IFB/1
5. Modification and Withdrawal of Bids	IFB/2
6. Signing of Bids.....	IFB/2
7. Bid Security.....	IFB/2
8. Bidder’s Statement of Qualifications.....	IFB/3
9. Award of Contract	IFB/3
10. Contract Execution.....	IFB/3
11. Contract Security	IFB/3
12. Time of Completion	IFB/3
13. Number of Contract Documents.....	IFB/3
14. Missouri Products and Missouri Firms.....	IFB/4
15. Supplier Diversity.....	IFB/4
16. List of Subcontractors.....	IFB/6

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

July 2024 Edition

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF ARTICLES

PAGE

- 1. GENERAL PROVISIONS..... GC/1**
 - 1.1 Basic Definitions GC/1
 - 1.2 Specifications and Drawings GC/3
 - 1.3 Required Provisions Deemed Inserted..... GC/4

- 2. OWNER..... GC/4**
 - 2.1 Information and Services Required of the Owner GC/4
 - 2.2 Owner’s Right to Stop the Work GC/4
 - 2.3 Owner’s Right to Carry Out the Work..... GC/4
 - 2.4 Extent of Owner Rights GC/5

- 3. CONTRACTOR GC/5**
 - 3.1 Contractor’s Warranty GC/5
 - 3.2 Compliance with Laws, Regulations, Permits, Codes, and Inspections GC/5
 - 3.3 Anti-Kickback GC/6
 - 3.4 Supervision and Construction Procedures GC/6
 - 3.5 Use of Site GC/7
 - 3.6 Review of Contract Documents and Field Conditions by Contractor..... GC/8
 - 3.7 Cleaning and Removal..... GC/8
 - 3.8 Cutting and Patching GC/8
 - 3.9 Indemnification..... GC/9
 - 3.10 Patents GC/9
 - 3.11 Delegated Design..... GC/10
 - 3.12 Materials, Labor, and Workmanship GC/10
 - 3.13 Approved Equal..... GC/11
 - 3.14 Shop Drawings, Product Data, Samples, and Coordination Drawings/BIM Models..... GC/11
 - 3.15 Record Drawings GC/12
 - 3.16 Operating Instructions and Service Manual..... GC/13
 - 3.17 Taxes GC/13
 - 3.18 Contractor’s Construction Schedules..... GC/14

- 4. ADMINISTRATION OF THE CONTRACT GC/14**
 - 4.1 Rights of the Owner..... GC/14
 - 4.2 Rights of the Architect..... GC/15
 - 4.3 Review of the Work..... GC/15
 - 4.4 Claims..... GC/15
 - 4.5 Claims for Concealed or Unknown Conditions GC/15
 - 4.6 Claim for Additional Cost GC/16
 - 4.7 Claims for Additional Time..... GC/16
 - 4.8 Resolution of Claims and Disputes..... GC/17
 - 4.9 Administrative Review GC/17

- 5. SUBCONTRACTORS GC/17**
 - 5.1 Award of Subcontracts GC/17
 - 5.2 Subcontractual Relations GC/18
 - 5.3 Contingent Assignment of Subcontract GC/18

- 6. SEPARATE CONTRACTS AND COOPERATION GC/18**

- 7. CHANGES IN THE WORK..... GC/19**
 - 7.1 Change Orders GC/19
 - 7.2 Construction Change Directive..... GC/19
 - 7.3 Overhead and Profit..... GC/20
 - 7.4 Extended General Conditions GC/21

7.5	Emergency Work.....	GC/21
8.	TIME	GC/21
8.1	Progress and Completion.....	GC/21
8.2	Delay in Completion.....	GC/21
8.3	Liquidated Damages.....	GC/22
9.	PAYMENTS AND COMPLETION.....	GC/22
9.1	Commencement, Prosecution and Completion.....	GC/22
9.2	Contract Sum	GC/23
9.3	Schedule of Values	GC/23
9.4	Applications for Payment	GC/24
9.5	Approval for Payment	GC/25
9.6	Decisions to Withhold Approval	GC/25
9.7	Progress Payments.....	GC/25
9.8	Failure of Payment.....	GC/26
9.9	Substantial Completion.....	GC/26
9.10	Partial Occupancy or Use	GC/26
9.11	Final Completion and Final Payment	GC/26
10.	PROTECTION OF PERSONS AND PROPERTY	GC/27
10.1	Safety Precautions and Programs	GC/27
10.2	Safety of Persons and Property.....	GC/27
11.	INSURANCE and BONDS	GC/28
11.1	Insurance.....	GC/28
11.2	Commercial General Liability	GC/28
11.3	Licensed for Use Vehicle Liability.....	GC/29
11.4	Workers' Compensation Insurance.....	GC/29
11.5	General Insurance Requirements and Professional Liability.....	GC/29
11.6	Builder's Risk Insurance	GC/30
11.7	Bonds.....	GC/31
12.	UNCOVERING AND CORRECTION OF THE WORK.....	GC/32
12.1	Uncovering of the Work.....	GC/32
12.2	Correction of the Work.....	GC/32
12.3	Acceptance of Nonconforming Work.....	GC/32
13.	MISCELLANEOUS PROVISIONS	GC/33
13.1	Written Notice	GC/33
13.2	Rights and Remedies	GC/33
13.3	Tests and Inspections.....	GC/33
13.4	Nondiscrimination in Employment Opportunity	GC/34
13.5	Supplier Diversity Goal Program	GC/34
13.6	Wage Rates.....	GC/34
13.7	Records.....	GC/36
13.8	Codes and Standards.....	GC/36
13.9	General Provisions.....	GC/37
13.10	Certifications.....	GC/37
14.	TERMINATION OR SUSPENSION OF THE CONTRACT	GC/38
14.1	Termination by Owner for Cause	GC/38
14.2	Suspension by the Owner for Convenience	GC/39
14.3	Owner's Termination for Convenience	GC/39

**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 Marinas.

.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 Serviced-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 existing 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 Contractors 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 on 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 not withstanding 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, lightning, 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 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. 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.

SECTION 1.E
SPECIAL CONDITIONS

1. DEFINITIONS

a. "Drawings"

Drawings referred to in and accompanying Project Manual consist of Drawings prepared by and bearing name of below defined Architect, bearing July 11, 2024 University of Missouri Healthcare Patient Care Tower – T1230 MRI Room.

b. Architect
OWH, Inc.
222 S. Bemiston Ave., Suite 200
Clayton, MO 63105
(314) 721-4050
(314) 721-6632

c. Mechanical & Electrical Engineer
Introba, Inc.
6 South Old Orchard
St. Louis, MO 63119
(314) 918-8383
(314) 918-1766

d. Structural Engineer
ASDG, LLC
1009 Lincoln Highway
Fairview Heights, IL 62208
(618) 628-0887
(618) 628-0889

SPECIAL SCHEDULING REQUIREMENTS

- a. The Contractor shall generally follow the phasing of the work as delineated in the Contract Documents.
- b. The Contractor shall take into consideration all temporary services, temporary cross ties, staging and temporary protection in scheduling and execution of the work.
- c. The Contract Documents do not detail all of the interim building systems temporary work. The Contractor is responsible to submit a detail schedule of shutdowns and temporary protection for review by the University Project Manager and Hospital.
- d. Special scheduling requirements supplemental to the bid form.
 - 1) Weekday daytime work hours are considered as hours Monday-Friday, between the hours of 7:00 a.m. and 5:00 p.m.

- 2) Night hours are defined as Monday through Thursday, after 5:00 p.m. and before 4:00 a.m.
 - 3) Weekend hours are defined as after 7:00 p.m. on Friday until 4:00 a.m. Monday.
 - 4) Excessive noisy work hours – All interior concrete demolition work shall occur between 7:00 a.m. and 5:00 p.m. Such work shall be coordinated and approved at least 72 hours in advance with Owner’s Representative.
 - 5) Utility outages must be coordinated with Owner’s Representative with a minimum of 14 calendar days’ notice.
 - 6) Electrical outages may only occur between the hours of 10:00 p.m. Thursday and 4:00 a.m. Friday unless approved by Owner’s Representative. Electrical feeders may be acceptable to be combined into a single outage while other feeders may require individual outages.
- e. Contractor shall perform all work in the designated out of phase areas 2nd and 3rd Floor areas outside of regular working hours, which are [7:00] a.m. to [5:00] p.m., Monday through Friday.
- f. Contractor shall coordinate installation of imaging system chiller provided by Imaging Vendor. Work to include reviewing rigging, hook-up and testing
- g. Contractor shall assist in making provision for MRI system delivery. It is expected that the MRI system will be delivered thru the completed Phase 1A and Phase 1B work areas.
- 1) The Contractor shall make provision to assist in the removal and reinstallation of OFOI demountable partition system.
 - 2) The Contractor shall assist the Owner with the coordination of delivery timeframe of the MRI system.
 - 3) The Contractor shall coordinate placement of temporary protection while the balance of the construction is completed after the delivery of the MRI system.
 - 4) The Contractor will be responsible for final RF system testing after the completion of the work and prior to substantial completion.
 - 5) Contractor shall make provision to accommodate build out of MRI RF Room Access (RF door and side panel and interior room finishes within 5 working days after MRI delivery).
 - 6) The Contractor will be responsible to cooperate with the coordination of the work with Owner’s Imaging Vendor.

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 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 the phased renovation of approximately 2,200 square feet of the existing MRI Suite to house a second MRI system.
- (2) Demolition: Project is comprised of the phased demolition of existing clinical space within the MRI Suite, adjacent clinical space on Floors 2 and 3, Minor cutting and patching on the roof and mechanical and electrical rooms in the lower level.
- (3) Architectural work is comprised of the phased build out of the clinical space to include out-patient waiting/dressing, in-patient holding, new MRI Exam Room, Equipment Room, and associated support space. Work to include new magnetic shielding system and new RF shielding system. Work will be required to modify the existing stone panel curtain wall system to provide opening for the new cryovent exhaust piping.
- (4) Structural work consists of minor support elements for RF shielding and opening in exterior stone panel curtainwall envelope.

(5) **Electrical**

5.1 Demolition

- a. All electrical work in scope of work area to be demolished. MRI Exam Room 1230 and Equipment Room 1229 is to remain existing. Demolition is to include all power, lighting, fire alarm, data/communication, security, and other related low-voltage devices. All lighting, low-voltage devices, not limited to for example security devices, nurse call stations and others called out on plans to be salvaged and given back to the owner or re-used during new work.

5.2 New Work

a. Lighting:

1. Existing LED Fixtures in scope of work area shall be salvaged and re-used during new work.
2. New LED lighting will be provided for the scope of work area depending on phasing of the project.
3. Emergency lighting will be provided and re-connected to the existing life-safety circuit in the area.
4. New lighting controls to be provided to meet energy code standards and local codes.
 - a. Ceiling type occupancy sensors to be passive infrared.
 - b. New light switches to be provided.

b. Power:

1. A new panel for the new MRI equipment room shall be provided to serve the new MRI equipment.
2. New power for the MRI equipment to be connected to NDP-1, a normal power distribution system.
 - a. UPS to be provided as part of the Siemens equipment package.

- b. Electrical drawings are to be coordinated with Siemens drawings. Siemens drawings are not provided as part of the construction documents.
- 3. New power for the MRI chiller shall be connected to RDP-1, a generator backed distribution system.
- 4. Wiring devices, such as receptacles are to follow code requirements for hospitals and university standards.
- c. Systems:
 - 1. Rough-ins will be provided for Nurse Call system as required.
 - a. Salvaged nurse call stations shall be re-used as part of the new work.
 - 2. New fire alarm devices to be provided to supplement the scope of work area as required.
 - 3. New security devices to be provided to the scope of work as required.
 - a. Salvaged security devices shall be re-used as part of the new work.
 - 4. New data/communication devices to be provided to the scope of work area as required.

(6) **Mechanical**

6.1 Demolition

- a. Variable Air Volume (VAV) Air Terminal Units with Hot Water Reheat.
 - 1. Remove all VAV's serving spaces within scope of work. Retain all VAV's to be reinstalled as part of new work.
 - 2. Remove all associated ductwork and piping back to main.
- b. Variable Exhaust Air Volume (VEV) Air Terminal Units.
 - 1. Remove all VEV's serving spaces within scope of work. Retain VEV's to be reinstalled as part of new work. Majority of renovated space will be added to return air system.
- c. Air Curtain (AC)
 - 1. Remove AC and all associated accessories and controls.
- d. Return Air (RA)
 - 1. Remove and relocate section of 66"x20" RA duct running over future MRI room.
- e. Chilled Water Piping (CHW)
 - 1. Remove existing chilled water piping from above MRI room.

6.2 New Work

- a. Variable Air Volume (VAV) Air Terminal Units with Hot Water Reheat.
 - 1. Provide VAV's for comfort cooling, minimum outside air ventilation, and heating for the spaces served.
 - 2. Route new supply air (SA) duct from the main to each VAV.
 - 3. Route new heating hot water (HHW) piping from the main to each VAV.
 - 4. All ductwork in MRI room shall be constructed of non-ferrous material.
- b. Variable Exhaust Air Volume (VEV) Air Terminal Units.
 - 1. Provide VEV to modulate the exhaust airflow serving the MRI room.
 - 2. Provide VEV to modulate the exhaust airflow serving the restroom.
- c. Computer Room Unit (CRU) with Chilled Water Cooling.
 - 1. Provide a CRU for cooling in the MRI equipment room.
 - 2. Route chilled water (CHW) piping from the main to the CRU.
- d. Duct Mounted Humidifier (H)
 - 1. Provide humidifier in duct serving the MRI room.

2. Provide humidifier in duct serving the MRI control room.
- e. Exhaust Fan (EF)
 1. Connect new ductwork serving the renovated space to the existing roof mounted exhaust fan (EF-21) to provide continuous exhaust from the space.
 2. Fan and duct will need to be re-balanced to new cfm values.
- f. MRI Chiller
 1. The chiller is provided by Siemens.
 2. Install the chiller on the roof at the 4th Floor.
 3. Route CHW pipe from roof to MRI equipment room.
- g. Cryogen Vent
 1. Provide cryogenic vent from new MRI machine. Provide a sidewall termination on the north face of the building.
 2. Coordinate exact termination with Siemens requirements.
- h. Return Air (RA) Duct
 1. Provide new 54x14 RA duct to be relocated to the west from over the new MRI room and new 24"x18" RA to be located to the east over the CT room.
 2. Install new smoke damper above corridor where the duct passes through the smoke barrier.
 3. Duct shall be mounted tight to structure.
 4. Route RA duct from the main to each space required in the scope of work.
- i. Exhaust Air Duct
 1. Route EA duct from the main to the MRI room and the restroom. All ductwork in MRI room shall be construction of non-ferrous material.

(7) **Plumbing**

7.1 Demolition

- a. Modifications to the existing medical gas piping serving MRI Exam 1230, Polarizer 1231, Holding 1232. The existing medical gas systems affected consist of medical air, nitrous oxide, medical vacuum, waste anesthesia gas disposal, and oxygen. The existing zone valve box serving this MRI suite will be demolished. This area is served by isolation valves therefore the medical gas work will not affect any medical gas outside of this area. The existing area alarm serving this area will need to be demolished. All existing medical gas outlets and associated piping will be demolished in the area of work. The contractor shall not leave any abandoned pipe or hangers above ceiling once demolition work is complete.
- b. The existing water closet, lavatory, floor drain, and all associated water, waste, and vent piping in toilet 1237 will need to be demolished back to nearest fitting and capped. Existing lavatory in holding 1232 will be demolished, existing vent to be capped just above ceiling for future extension. Existing domestic hot and cold water serving existing lavatory in holding 1232 will be demolished back to existing domestic water mains in corridor. Existing sanitary serving the existing lavatory in holding 1232 will be demolished to just below floor and capped for future connection. Existing sink in research 1226 to be removed, associated water to be removed back to nearest valves and cap above ceiling. Existing waste and vent serving sink in research 1226 to be removed back to nearest fitting and capped. All existing floor slab penetrations to be patched. The existing vent, waste, and water system

demolition work may require a temporary system shut down. Any and all ferrous piping above existing MRI to either be removed and replaced by an appropriate non-metallic pipe type or covered by proper shielding.

7.2 New Work

- a. Three new zone valve boxes will be provided for the updated MRI suite. One zone valve box for the existing MRI, one zone valve box for the two holding rooms, and one zone valve box for the new MRI. New nitrous oxide, medical air, medical vacuum, waste anesthesia disposal, and oxygen will be extended to the three new zone valve boxes. New medical gas lines will be extended to the new medical gas wall outlets. A new zone valve box and an area alarm shall be installed during phase 1b. The contractor shall ensure the operations of the existing MRI are not affected during construction.
- b. New domestic hot, domestic cold, will be extended to the new lavatory in the new restroom from the existing hot and cold-water lines just above the space. New vent and sanitary will be extended from existing sink in existing soiled utility plan south of the new restroom. New cold water and vent will be extended to the new water closet in the new restroom from the nearest main of appropriate size. New sanitary will be extended in the ground floor space to water closet location. New domestic hot, domestic cold, and vent to be extended to new sink at patient care station. New sanitary to be extended from existing capped sanitary below floor on the ground level to new sink location on the first floor. Cold water to be extended from main of appropriate size to coffee kiosk area to a new outlet box for coffee maker. All domestic water, sanitary, and vent ties-ins to require temporary system shut down.

(8) **Fire Protection**

8.1 Demolition

- a. The existing fire protection branch piping and sprinkler heads will be removed as required to accommodate the new ceiling layout and the installation of MEP items. The new MRI room and equipment room will be protected by the existing pre-action system. Any existing schedule 10 piping or galvanized piping shall be removed and replaced with schedule 40 black steel. A temporary system shut down will be required.

8.2 New Work

- a. New fire protection branch piping will be provided and modified as required to accommodate new room and ceiling layout. New sprinkler heads will be provided and coordinated with ceiling devices. A new Tyco pre-action sprinkler system will be provided to serve the new MRI room, and MRI equipment room. All fire protection piping, sprinkler heads, and associated components above the MRI shall be non-magnetic.

4. LOCATION

Work shall be performed under this Contract on campus of the University of Missouri - **Columbia, at University Hospital Patient Tower.**

5. NUMBER OF CONSTRUCTION DOCUMENTS

- a. 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 referenced 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 Location
- (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.3) for 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.4).

d. The Contractor shall submit to the Owner's Representative all items referenced in the accompanying Closeout Log (1.E.5) 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. NOTIFICATION

Before beginning Demolition Work or service outages, the Contractor shall provide, at minimum, seventy-two (72) hours advance notice to Owner's Representative for purpose of verifying utility locations including, but not limited to, gas, telecommunications, electric, water, steam, sewer, and nitrogen. Contractor shall minimize the number of outages, minimize the length of outages and related work shall be continuous until the utility is restored.

8. USE OF PREMISES

a. Access: Access to construction site shall be as indicated on Drawings and as directed by the Owner's Representative.

- b. Parking: Contractor shall be issued parking permits for Zero (0) service vehicles to park in location directed by the Owner's Representative. 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.
- b. Parking:
- (1) Parking of personal vehicles within project access/lay down/staging areas is prohibited. Violation of this requirement may result in ticketing and/or towing at the vehicle owner's expense and suspension of progress payments.
 - (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. 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 satisfaction of the Owner's Representative, at no cost to the Owner.
- e. Restroom: Toilets and toilet location shall be subject to approval by the Owner's Representative.
- f. 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 smoking any tobacco products, including e-cigarettes.
- g. Landfill: The Contractor shall not use the Owner's landfill. Dumping or disposal of excavated or demolition materials on Owner's property shall not be permitted. The Contractor shall remove and legally dispose of excavated or demolished materials off the Owner's property.
- h. 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.
- i. 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 ~~is~~ 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 at [Discharge to Sewer Request Form](#). The contractor should submit the form to the Owner's Representative, not to the Department of Environmental Health and Safety as the form indicates.
- j. All concrete waste material including washout water shall be totally contained and removed from the Owner's property.

- k. 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.

- l. **“Permit Required Confined Space” Entry Communication and Coordination**

There are no known “permit required confined spaces” within the project limits. Each contractor shall conduct a survey to confirm whether or not any confined spaces exist within the project limits. It is incumbent upon each contractor to list all “permit required spaces”.

The Contractor shall notify the Owner's Representative if 1) conditions change resulting in a non-permit required confined space being reclassified to a “permit required confined space” after evaluation of the space by a competent person; 2) a space previously thought to be non-permit required space is classified as a “permit required confined space”; or 3) during the course of construction a “permit required confined space” is created after evaluation by a competent person.

The Contractor shall submit to the Owner's Representative a copy of the cancelled confined space entry permit and a written report summarizing the permit space program followed and all hazards confronted or created during entry operations. This information shall be submitted within one week of cancelling the permit.

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 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 Owner 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) Fence screening fabric shall be used on all perimeter fencing. Fabric shall be green in color, full height of the project fence, securely attached and properly maintained throughout the duration of the project.
- (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.
- (2) 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.
- (3) 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.
- (4) Pruning of limbs necessary to repair damage or provide clearance for work shall be **done by the MU Landscape Services Department** at the direction of the Owner's Representative.

10. SUBSTITUTIONS and EQUALS

- a. Substitutions are defined in General Conditions article 3.11.8 for and Equals are defined General Conditions Article 3.12 .

- 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.
- b. 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.
- c. No substitutions and/or equal will be allowed for the following items:

<u>Item</u>	<u>Specification Section</u>
Lock Cylinders [Best]	08710
Magnetic Shielding	13 4906
RF Shielding	13 4941
Gas Piping for Laboratory and Healthcare Facilities	22 6313

11. CODES AND STANDARDS

The Contractor shall comply with applicable codes and standards as listed in General Conditions.

12. PERMITS – N/A.

13. SPECIALTIES

- a. Contractor shall coordinate with Imaging System Vendor for delivery of Imaging System Vendor chiller to ensure receiving, rigging, installation, start up and operation check out prior to delivery of MRI magnet.

14. PRE-BID INSPECTION

All pre-bid inspections of work areas shall be scheduled with pre-bid inspection guide, telephone: (573) 882-2228.

- a. Pre-Bid Meeting schedule for July 18, 2024

15. ROOF WARRANTY REQUIREMENT

- a. Owner has an existing roof warranty on roof of 30 years (2013) and is included at the end of this section. The Contractor shall verify roofing manufacturer and warranty provider. The Contractor shall use a licensed applicator of existing roofing system to make and repair roof penetrations in order for the Owner's existing warranty to remain in full force and effect.

Roof System Manufacturer:
Name: Johns Manville Roofing Systems Group
Roof Type: PVC
Installer: Missouri Builders Service Inc.
Manufacturer's Warranty:
Substantial Completion: January 18, 2013
Expiration Date:

16. 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 UM Executive 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.

17. MODIFICATION TO INFORMATION FOR BIDDERS: BIDDERS STATEMENT OF QUALIFICATIONS

- a. Information For Bidders

- (1) Reference: Information for Bidders, Article 8.4

Insert 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:

The project requires the services of a prime contractor who has demonstrated success in completing process/power plant work in an operating plant environment with little or no interruption of plant operations.

(a) MINIMUM QUALIFICATIONS

- (i) The schedule for the project is aggressive and requires a contractor with a successful track record of managing projects with average monthly expenditures of more than \$3 Million Dollars.
- (ii) Successful completion of one project of similar type and scope.
- (iii) Successful and sustained track record of effectively utilizing project/schedule management software for at least the last two years.

(b) QUALIFICATION SUBMITTALS

- (i) Submitted qualification packages should include the following information:
 - Project and Schedule
 - Management Experience managing projects 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.

18. MODIFICATIONS TO GENERAL CONDITIONS

a. General Conditions:

- (1) Reference: General Conditions Article 11.2.1 Commercial General Liability.

19. PROJECT SCHEDULING

The project scheduling specification for the project are included immediately after the Special Conditions. For this project the Contractor shall meet the following scheduling requirements.

Contractor Schedule – Contractor is responsible for the schedule and he may provide with in-house personnel or hire a third party scheduling consultant. See Contractor Schedule Specification included in these documents.

20. 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 included under different Sections that depend on each other for proper installation, connection, and operation.

- (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 **Twenty One (21) 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.

21. BUILDING SYSTEM COMMISSIONING

- a. The University will hire an independent third party Commissioning Agent.
- b. Contractor shall provide all personnel and equipment required to assist with the Commissioning Plan.
- c. The contractor shall designate a competent person, either the superintendent or Project Manager, to act as the contractor's commissioning coordinator. The commissioning coordinator is responsible for planning, scheduling, coordinating, conducting and verifying all commissioning activities required by the commissioning plan and ensuring all building systems are complete, operable and ready for use by the Owner. At a minimum, RF and Magnetic Shielding Systems, building ventilation systems, chilled generation systems, hydronic distribution systems, Cryogenic exhaust system, power distributions systems and fire detection and alarm systems, as applicable.

22. 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.

23. COST BREAKOUT FOR OWNER'S ACCOUNTING PURPOSES – N/A

24. PROJECT MANAGEMENT/COMMUNICATION REQUIREMENTS

- a. The Contractor shall be represented at the site by either a competent full-time Project Manager and/or 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 use a current industry standard (Primavera, Microsoft Project, etc.) project scheduling software which provides as a minimum: Critical paths, milestones, estimated and actual start and completion dates, scheduled vs. actual progress, and detailed task and subtask breakdown. The following schedules shall be provided as a minimum and kept current: Overall project schedule, four- (4-) week look-ahead, and two- (2-) week look-ahead.
- c. **Ben Advise** 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 [**edit per the PM to fit the project requirements and/or campus method of communicating, and file storage/retrieval systems**]. Field staff are also required to utilize this software as directed by the Owner's Representative.
- d. The Contractor will be allowed use of the Hospital WIFI for communication purposes.

25. 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.

26. 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 2014 NFPA 51B.

- b. Hot work shall be defined as any work involving burning, welding, grinding, cutting, or similar operations that are capable of initiating fires or explosions.
- c. The Contractor shall utilize the hot work permit decision tree and permit provided in the 2014 NFPA 51B for all Hot Work operations.
- d. A hot work permit shall be used on all hot work performed outside a designated hot work area. The 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.
- e. 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.
- f. MUHC will collect and file Hot Work Permits.

PERMITS

- a. Before commencement of Boilers, Water Heaters or Pressure Vessels, the Contractor must obtain an installation permit from the State of Missouri, Division of Fire Safety, Boiler and Pressure Unit as required by 11 CSR 40-2.010 through 11 CSR 40-2.065. The permit applications are available at: <https://www.dfs.dps.mo.gov/programs/bpv/>.
- b. MU Facilities Planning and Development (MU FPD) will review documents for permitting and code inspection. A temporary Certificate of Occupancy and Certificate of Occupancy process will be incorporated into this project.
- c. The Contractor shall be responsible for coordinating inspections with MU FPD.

27. GENERAL REQUIREMENTS FOR CRANE AND HOISTING OPERATIONS

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.

- a. Only fully certified and evaluated Operators shall perform equipment operations. Operators in an "Operator in Training" status shall not be used.
- b. Submittal requirements:
 - 1. Submit copies of Operator certifications, licenses, and evaluations to the Owners Representative.
 - 2. Submit Rigger and Signal Person qualifications to the Owners Representative.

3. 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.

28. **WARRANTY WALKTHROUGH**

Contractor shall attend a walk-thru with the Owner at 11 months after acceptance to review and document any warranty items to be addressed as part of the 12 month warranty stated in article 3.1 of the General Conditions.

END OF SECTION

Contractor Schedule

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 that the critical milestone and end dates spelled out in the contract are achieved.
- b) Related Documents
Drawings and general provisions of the Contract, including General Conditions' Article 3.17 shall apply to this Section.
- c) Stakeholders
A Stakeholder 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 subcontractors.
- d) Weather
 - (1) Contractor acknowledges that there will be days in which work cannot be completed due to the weather, and that a certain number of these lost days are to be expected under normal weather conditions in Missouri.
 - (2) 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 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.
 - (3) 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

2. SCHEDULING PROCESS

- a) The intent of this section is to insure 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
 - (1) Schedule Development
Contractor shall prepare the Project Schedule using Primavera P3 or Oracle P6.
 - (2) Schedule Development
Within 4 weeks of the NTP, contractor shall prepare a schedule, in CPM format, that reflects the contractor's and each subcontractors plan for performing the contract work.

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.

(3) Schedule Updates.

- (a) Schedule Updates will be conducted once a month, at a minimum.

Actual Start and Finish dates should be recorded regularly during the month. Percent Complete, or Remaining Duration shall be updated as of the data date, just prior to Contractor's submittal of the update data.

- (b) Contractor will copy the previous months schedule and will input update information into the new monthly update version.

- (c) 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:

(i) Review out of sequence progress, making adjustments as necessary,

(ii) Add any fragments necessary to describe changes or other impacts to the project schedule and

(iii) Review the resultant critical and near critical paths to determine any impact of the occurrences encountered over the last month.

(4) 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.

(5) Progress Meetings

- (a) 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.

- (b) Submit progress schedules to subcontractors to permit coordinating their progress schedules to the general construction work. Include 4 week 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 path 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.3, 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 including the following, in addition to Contractor's work.
 - (1) Phasing: Provide notations on the schedule to show how the sequence of the Work is affected by the following:
 - (a) Requirements for phased completion and milestone dates.
 - (b) Work by separate contractors.
 - (c) Work by the Owner.
 - (d) Coordination with existing construction.
 - (e) Limitations of continued occupancies.
 - (f) Uninterruptible services.
 - (g) Partial occupancy prior to Substantial Completion.
 - (h) Area Separations: Use Activity Codes to identify each major area of construction for each major portion of the Work. For the purposes of this Article, a "major area" is a story of construction, a separate building, or a similar significant construction element.

4. TIME EXTENSION REQUESTS

- 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:

 - (1) 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.
 - (2) 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.
 - (a) If the adjustments above result in the completion date being brought back within the contract time period, no adjustment will be made in the contract time.
 - (b) If the adjustments above still 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.
 - (c) 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 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 shall be considered compensable. The actual costs, if any, of the Contractor's time sensitive jobsite supervision and general conditions costs, shall be quantified and a change order issued for these costs.

UNIVERSITY OF MISSOURI
ROOF SYSTEM MANUFACTURERS CERTIFICATION
(Revised 12/94)

TO: _____ Title _____
Project No. _____
Location _____

Our technical staff has examined the Architect/Engineer's Drawings, Specifications and required warranty for the roofing work on this project. We do not wholly endorse the building design or any materials or services not part of our advertised roofing system.

CERTIFICATION

We hereby certify that:

1. All materials we will furnish and deliver to the project shall be of good merchantable quality, shall meet or exceed the Specifications required and shall, if properly applied by one of our approved roofing applicator firms in accord with our instructions, provide a sound weather/watertight roofing system.
2. Upon completion of the installation in accord with the Drawings and specifications and our recommended installation procedures, we shall issue a total system warranty specified in the project Specifications.
3. The Drawings and Specifications follow the recommendations of our roofing manual for this type of roofing system with:

No exceptions.

The following exceptions: (The roofing system will be approved for this project if the following changes are made to the Contract Documents. The bid provided with this Document includes the required changes).

NOTE: Exceptions may cause Owner to reject bid.
Exceptions are as follows:

4. The Warranty will be issued for the following proposed roofing system:

ROOFING SYSTEM MANUFACTURER: _____

Authorized Signature: _____

Title: _____ Date _____

Telephone Number: () _____

Fax Number: () _____

UNIVERSITY OF MISSOURI
CONTRACTORS ROOFING/FLASHING/SHEET METAL GUARANTEE
(Revised 12/94)

WHEREAS (NAME AND ADDRESS OF COMPANY) _____

herein referred to as Roofing Contractor, certify that they have furnished and installed all roofing, flashing, sheet metal and related components in accordance with the Contract Documents and as required by the Roofing System Manufacturer's installation instructions on the facility described below:

Facility: _____

Owner: University of Missouri-(CAMPUS)
(CAMPUS ADDRESS)

Date of Full Completion: _____

Approximate Area of Roof: _____

Type of Roofing Material: _____

Manufacturer's Specification Number: _____

Thickness and Type of Roof Insulation: _____

NOW, THEREFORE, Roofing Contractor guaranties to the Owner, subject only to the exclusions stated hereinafter, that all roofing, flashing and sheetmetal work is fully and integrally watertight and is free from faults and defects in material or workmanship, and is guaranteed for a period of three (3) years from date of full completion of work.

EXCLUSIONS: This guarantee does not cover, and Roofing Contractor shall not be liable for the following:

1. Damage to the roofing system caused by fire, lightning, tornado, hurricane or hailstorm.
2. Damage to roofing system caused by significant settlement, distortion or failure of roof deck, walls, or foundations of building, excepting normal building expansion and contraction is not a part of this exclusion.
3. Abuse by the Owner and/or third parties.

REPAIRS: Owner shall promptly notify Roofing Contractor, in writing, of the need for repair of roofing, flashing, or sheet metal:

1. Roofing Contractor, within eight (8) hours after receipt of such notice, shall make emergency repairs at its expense, as required to render the facility watertight.
2. Within five (5) days after receipt of such notice, Roofing Contractor shall at its expense correct any faults or defects in material or workmanship.
3. Should needed repairs not be covered by this guarantee, Roofing Contractor, after having obtained Owner's written consent, shall make such repairs at Owner's expense. Following said repairs, this guarantee shall thereafter remain in effect for the unexpired portion of the original term. If Owner does not so consent or repairs are made by others than the Roofing Contractor, this guarantee shall terminate for those parts of the roof affected by the repair.
4. In the event that Owner has notified the Roofing Contractor of the need for repairs and (i) Roofing Contractor does not immediately make repairs, or (ii) Roofing Contractor disclaims responsibility for the repairs and Owner disagrees, or (iii) Owner considers Roofing Contractor's quoted cost for repairs not covered by this guarantee to be unreasonable and, an emergency condition exists which requires prompt repair to avoid

substantial damage or loss to Owner, then, Owner may make such temporary repairs as he finds necessary and such action shall not be a breach of the provisions of this guarantee.

ANNUAL INSPECTIONS: Roofing Contractor shall inspect roof installation prior to each of the three anniversary dates from date of full completion of the work.

1. Inspection team to include Roofing Contractor, Roof Manufacturer, and Owner=s Representative.
2. Inspection of total roof system will be included in the annual inspections.
3. All defects in total roof system will be corrected by the Roofing Contractor within 30 days of inspection.
4. Roof manufacturer will certify by a written report that roof inspection has been completed, defects are acknowledged, and will warrant any repairs.
5. All corrective work completed by Roofing Contractor shall be warranted as approved by the Roofing Manufacturer.

ROOF MODIFICATION: Should Owner require work to be done on roof of said facility including modifications, alternations, extensions or additions to roof and including installation of vents, platforms, equipment, bracings or fastenings, Owner shall notify Roofing Contractor and give Roofing Contractor an opportunity to make recommendations as to methods necessary to safeguard against damage to roofing covered by this guarantee. Failure of Owner to give Roofing Contractor such opportunity or failure to follow methods recommended by Roofing Contractor shall render this guarantee null and void to the extent such failure should result in damage to roofing covered by this guarantee.

NOTICES: Notification of Roofing Contractor by Owner, shall be fulfilled by sending notice to Roofing Contractor.

IN WITNESS WHEREOF, we set our hands this ____ day of _____, 20__.

By: _____

Title: _____

For Roofing Contractor

Name: _____

Address: _____

Phone: _____

SHOP DRAWING AND SUBMITTAL LOG

Project: University of Missouri HealthCare
 Patient Care Tower – T1230 MRI Room

Project Number: CP245321

Contractor:

Section	Description	Contractor	Date Rec'd	#	Date Sent to Cons.	Date Ret'd	Remarks	Date ret'd	Cont'r	Copies To Owner	File
02 4116	Program of Methods and Time Schedule										
	Report of Inspection										
03 5400	Product Data										
	Certificate										
05 4000	Product Data										
	Shop Drawings										
	Stud Design Calculations										
05 5000	Product Data										
	Shop Drawings										
	Welder's Certificates										
06 1000	Product Data										
	Manufacturer's Certificate										
06 2000	Product Data										
	Shop Drawings										
06 4130	Product Data										
	Samples										
	Shop Drawings										
07 5300	Product Data										

	Shop Drawings										
	Manufacturer's Certificate										
	Manufacturer's Field Reports										
07 6200	Shop Drawings										
	Samples										
07 8400	Schedule of Firestopping										
	Product Data										
	Sustainable Design Submittal										
	Manufacturer's Certificate										
	Certificates										
	Certificate from Authority										
07 9200	Product Data for Sealants										
	Product Data for Accessory Products										
	Color Samples for Selection										
	Samples for Verification										
	Preinstallation Field Adhesion Test Reports										
08 1113	Product Data										
	Shop Drawings										
	Manufacturer's Certificate										
08 1416	Product Data										
	Shop Drawings										
	Samples										
083100	Product Data										

	Shop Drawings										
08 4229	Shop Drawings										
	Product Data										
08 4229.23	Shop Drawings										
	Product Data										
08 7100	Product Data										
	Hardware Schedules										
	Keying Schedule										
08 8000	Product Data on Glazing Unit Glazing Types										
	Samples										
	Manufacturer's Certificate										
09 2116	Product Data										
09 2216	Product Data										
09 3000	Product Data										
	Shop Drawings										
	Samples										
	Manufacturer's Certificate										
09 5100	Shop Drawings										
	Product Data										
	Samples										
09 5300	Product Data										
09 6500	Product Data										
	Shop Drawings										
	Verification Samples										

	Concrete Testing										
	Manufacturer's Certificate										
	Certification										
09 6813	Product Data										
	Shop Drawings										
	Samples										
	Concrete Subfloor Test Report										
09 9123	Product Data										
	Samples										
	Certificate										
10 2123	Product Data										
	Shop Drawings										
	Samples										
10 2601	Product Data										
	Samples										
	Shop Drawings										
10 2800	Product Data										
10 4400	Product Data										
	Shop Drawings										
	Manufacturer's Certificate										
10 9990	Product Data										
	Shop Drawings										
	Samples										
13 4906	Shop Drawings										

	Structural Calculations										
	Samples										
	Test Reports										
20 0800	Product Data										
	Product Certificates										
	Shop Drawings										
	Welder Certificates										
	Manufacturer's Seismic Qualification Certification										
	Contractor's Acknowledgement of Seismic Responsibility										
21 0500	Product Data										
	Welding Certificates										
21 1313	Product Data										
	Shop Drawings										
	Delegated-Design Submittal										
	Qualification Date										
	Approved Sprinkler Piping Drawings										
	Welding Certificates										
	Fire-Hydrant Flow Test Report										
	Field Test Reports and Certificates										
	Field Quality-Control Reports										
22 0500	Product Data										
	Shop Drawings										
	Coordination Drawings										

	Samples										
22 0523	Product Data										
22 0529	Product Data										
	Shop Drawings										
	Welding Certificates										
22 0700	Product Data										
	Shop Drawings										
	Samples										
	Installer Certificates										
	Material Test Reports										
	Field Quality-Control Inspection Reports										
22 1116	Product Data										
	Sustainable Design Submittals										
	System Purging and Disinfecting Activities Report										
	Field Quality-Control Reports										
22 1119	Product Data										
	Shop Drawings										
	Field Quality-Control Reports										
22 1316	Product Data										
	Sustainable Design Submittals										
	Seismic Qualification Certificates										
	Field Quality-Control Reports										

22 1319	Product Data										
	Shop Drawings										
	Seismic Qualification Certificates										
	Field Quality-Control Reports										
22 1413	Product Data										
	Seismic Qualification Certificates										
	Field Quality-Control Reports										
22 4300	Product Data										
	Shop Drawings										
22 6113	Product Data										
	Qualification Data										
	Seismic Qualification Certificates										
	Material Certificates										
	Brazing Certificates										
	Field Quality-Control Reports										
22 6213	Product Data										
	Qualification Data										
	Material Certificates										
	Brazing Certificates										
	Field Quality-Control Reports										
22 6313	Product Data										
	Shop Drawings										

	Qualification Data										
	Material Certificates										
	Brazing Certificates										
	Field Quality-Control Reports										
23 0500	Product Data										
	Shop Drawings										
	Coordination Drawings										
23 0513	Product Data										
23 0519	Product Data										
	Product Certificates										
23 0523	Product Data										
23 0529	Product Data										
	Shop Drawings										
23 0548	Product Data										
	Shop Drawings										
	Manufacturer Seismic Qualification Certification										
23 0700	Product Data										
	MSDS (Material Safety Data Sheet)										
	Shop Drawings										
23 0900	Shop Drawings										
	Product Data										
	Schematic Flow Diagrams										
	Label Each Control Device										
	Indicate All Required Electrical										

	Wiring										
	Provide Details of Faces on Control Panels										
	Written Description of Sequence of Operation										
	Provide Wiring Diagrams and I/O Panels										
	Provide Field Routing										
23 2113	Product Data										
	Shop Drawings										
	Welding Certificates										
	Qualification Data										
	Field Quality-Control Test Reports										
23 2213	Product Data										
	Test Reports										
23 3113	Product Data										
	Coordination Drawings										
	Field Quality-Control Test Reports										
	Welding Certificates										
	NFPA Compliance										
	AMCA Compliance										
	ASHRAE Compliance										
	ANSI/SMACNA Standard 001-2008 Seismic Restraint Manual										
	ANCI/SMACNA Standard 016-2012 HVAC Air Duct Leakage Test Manual										

	ACR 2006: National Air Duct Cleaners Association										
23 3300	Product Data										
23 3600	Product Data										
	Shop Drawings										
	Verify Compliance										
	Wiring Diagrams										
	Field Quality-Control Reports										
23 3713	Product Data										
23 8123	Product Data										
	Shop Drawings										
	Wiring Diagrams										
	Seismic Qualification Certificates										
	Field Quality-Control Reports										
23 8413	Product Data										
	Shop Drawings										
	Wiring Diagrams										
	Field Quality-Control Reports										
26 0519	Product Data										
26 0526	Field Test Reports										
26 0533	Product Data										
26 0536	Product Data										
	Shop Drawings										
	Coordination Drawings										
26 0573	Product Data										

	Qualification Data										
	Submittals										
26 0923	Product Data										
	Shop Drawings										
	Lighting Plan										
26 2416	Product Data										
	Shop Drawings										
	Seismic Qualification Certificates										
26 2726	Product Data										
26 2816	Translucent Log-Log Graph Paper										
26 5100	Product Data										
	Custom Luminaires										
28 3111	Product Data										
	Shop Drawings										
	Field Quality-Control Reports										

OPERATING INSTRUCTIONS AND SERVICE MANUAL LOG

Project: University of Missouri HealthCare
 Patient Care Tower – T1230 MRI Room

Project Number: CP245321

Contractor:

Section	Description	Catalog Data	Wiring Diagrams	Installation Instructions	Service & Maintenance Instructions	Parts List & Availability	Performance Curves	Startup & Operating Instructions
08 4229	Automatic Entrances	X	X		X			
08 4229-13	Sliding Automatic Entrances	X	X		X			
08 7100	Door Hardware		X	X	X	X		
09 3000	Tiling				X			
09 5100	Acoustical Ceilings				X			
09 6500	Resilient Flooring				X			
09 9123	Interior Painting				X			
10 4400	Fire Protection Specialties				X			
13 4942	Radio Frequency Shielded Enclosure		X		X	X		
21 1313	Wet Pipe Sprinkler Systems	X	X		X	X		X
22 0523	Valves	X						
22 1119	Domestic Water Piping Specialties	X			X			X
22 1319	Sanitary Waste Piping Specialties	X			X			X
22 4300	Plumbing Fixtures	X	X		X	X		
22 6113	Compressed Air Piping for Healthcare Facilities	X			X	X		X
22 6213	Vacuum Piping for Laboratory and Healthcare Facilities	X			X	X		X
22 6313	Gas Piping for Laboratory and Healthcare Facilities	X			X	X		X
22 0500	Basic Mechanical and Methods	X		X				

23 0513	Motors	X	X		X	X		
23 0519	Meters and Gages	X			X		X	X
23 0523	Valves	X			X	X		X
23 0548	Vibration and Seismic Controls for HVAC	X					X	
23 0900	Controls	X	X	X	X	X	X	X
23 2113	Hydronic Piping / Hydronic Specialties	X			X			
23 3300	Duct Accessories	X			X			X
23 3600	Air Terminal Units	X	X	X	X			X
23 3713	Diffusers, Registers, and Grilles	X						
23 8123	Computer Room Air Conditioning Systems	X	X	X	X	X	X	X
23 8413	Humidifiers	X	X	X	X	X		X
26 0536	Cable Trays	X						
26 0573	Power System Studies	X					X	
26 0923	Lighting Control Devices	X	X		X	X		X
26 2416	Panel Boards	X	X					
26 2726	Wire Devices	X						
26 2816	Enclosed Switches	X	X		X			
26 5100	Interior Lighting	X	X		X			X
28 3111	Digital, Addressable Fire Alarm System	X	X	X	X	X		X

CLOSEOUT LOG

Project: University of Missouri HealthCare
 Patient Care Tower – T1230 MRI Room
 Project Number: CP245321 Contractor:

Section	Description	Contractor/Subcontractor	Date Rec'd	# of Copies	CPM Initials	Remarks
GC /3.11	As-built drawings					
GC /13.5.6	Final Affidavit of Supplier Diversity Participation for each Diverse firm					
SC/20	Executed commissioning plan w/ required documentation					
	List special warranties and guarantees for each section					
	List any required maintenance stock, spare parts, etc.					
	List any special tools, keys, etc.					
02 4116	Project Record Documents					
07 5300	Warranty					
08 1416	Warranty					
08 3100	Project Record Documents					
08 4229	Project Record Documents					
	Maintenance Data					
	Warranty					
08 4229.23	Maintenance Contract					
	Project Record Documents					
	Maintenance Data					
	Warranty					
08 4229.23	Maintenance Contract					

08 7100	Maintenance Data					
	Warranty					
08 8000	Warranty Documentation					
09 3000	Maintenance Data					
09 6500	Maintenance Manuals					
09 6813	Operation and Maintenance Data					
	Maintenance Materials					
09 9123	Maintenance Data					
10 4400	Maintenance Data					
13 4942	Operation and Maintenance Instructions					
20 0800	Maintenance Data					
21 1313	Operation and Maintenance Instructions					
22 0533	Maintenance Data					
21 1119	Operation and Maintenance Data					
22 1319	Operation and Maintenance Data					
22 4300	Operation and Maintenance Data					
22 6113	Operation and Maintenance Data					
22 6213	Operation and Maintenance Data					
22 6313	Operation and Maintenance Data					
	Furnish Extra Materials					
23 0519	Operation and Maintenance Data					
23 0529	Maintenance Data					
23 2113	Operation and Maintenance Data					
23 2213	Operation and Maintenance Data					
23 3113	Record Drawings					

23 3300	Operation and Maintenance Data					
23 3600	Operation and Maintenance Data					
23 8123	Warranty					
	Operation and Maintenance Data					
23 8413	Operation and Maintenance Data					
26 0923	Operation and Maintenance Data					
26 5100	Furnish Extra Materials					
28 3111	Installation and Maintenance Manuals					
	Operation and Maintenance Data					
	Software and Firmware Operational Documentation					
	Project Record Documents					

CP245321 PCT T1230 MRI ROOM 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	<input checked="" type="checkbox"/>
24116						
Demolition for Remodeling						
Maintain dust control using temp enclosures and wet mopping floors to eliminate trackable dirt						<input type="checkbox"/>
Perform Field Quality Control section of specifications					Test Report	<input checked="" type="checkbox"/>
54000						
Cold-Formed Metal Framing						
Provide welder qualification report for each welder on site					Welder Qualifications	<input checked="" type="checkbox"/>
55000						
Metal Fabrications						
Provide welder qualification report for each welder on site					Welder Qualifications	<input checked="" type="checkbox"/>
61000						
Rough Carpentry						
Perform Field Quality Control section of specifications					Test Report	<input checked="" type="checkbox"/>
64130						
Custom Plastic Laminate Casework						
Conduct pre-installation meetings per specifications.					Meeting Minutes	<input checked="" type="checkbox"/>

Commissioning Items by CSI Division	Verified by:		Date compl	Coord Initial	Documentation Required	Owner Witness Required
	Name	Firm				
75300						
Elastomeric Membrane Roofing						
Conduct a preinstallation conference at project site per specifications					Document proceedings; provide copy to participants	<input checked="" type="checkbox"/>
Perform Field Quality Control section of specifications					Test Report	<input checked="" type="checkbox"/>
Perform Final Roof Inspection (Manufacturer's Rep)					field report	<input checked="" type="checkbox"/>
76200						
Sheet Metal Flashing and Trim						
Perform Field Quality Control section of specifications					Test Report	<input checked="" type="checkbox"/>
78400						
Firestopping						
Build Mockups as specified					Inspection Report	<input checked="" type="checkbox"/>
Perform Field Quality Control section of specifications					Test Report	<input checked="" type="checkbox"/>
79200						
Joint Sealants						
Perform tests per specifications.					field report	<input checked="" type="checkbox"/>
81113						
Hollow Metal Doors and Frames						
Inspect label for fire rated doors and frames					itemized list of doors	<input checked="" type="checkbox"/>

Commissioning Items by CSI Division		Verified by:		Date compl	Coord Initial	Documentation Required	Owner Witness Required
		Name	Firm				
81416							
Flush Wood Doors							
Inspect label for fire rated doors and frames						Door List	<input checked="" type="checkbox"/>
84229							
Automatic Entrances							
Perform Demonstration and Instructions section of spec						Sign-In Sheet	<input checked="" type="checkbox"/>
Sliding Automatic Entrances							
Perform Field Quality Control section of specifications						Test Report	<input checked="" type="checkbox"/>
87100							
Door Hardware							
Perform Field Quality Control section of specifications						Test Report	<input checked="" type="checkbox"/>
Verify that all fire doors close and latch positively						test report	<input type="checkbox"/>
87111							
Door Hardware							
Verify door closures comply with ADA requirements							<input type="checkbox"/>
92116							
Gypsum Board Assemblies							
Verify fire rating compliance is maintained, including all wall penetrations. Ensure walls stenciled as specified						inspection report	<input checked="" type="checkbox"/>

Commissioning Items by CSI Division	Verified by:		Date compl	Coord Initial	Documentation Required	Owner Witness Required
	Name	Firm				
95100						
Acoustical Ceilings						
Complete all above ceiling inspections prior to installation of tiles						<input checked="" type="checkbox"/>
Provide Extra Material as specified					Transmittal	<input checked="" type="checkbox"/>
96500						
Resilient Flooring						
After installation maintain ambient temperature of not less than 55 deg F or more than 95 deg F.						<input type="checkbox"/>
Perform pH, Chloride (moisture) and bond tests per manufacturer. Do not proceed until all manufacturing requirements are met.					test reports	<input checked="" type="checkbox"/>
Provide Extra Material as specified					Transmittal	<input checked="" type="checkbox"/>
96813						
Tile Carpeting						
Provide Extra Material as specified					Transmittal	<input checked="" type="checkbox"/>
99123						
Interior Painting						
Periodically Check Wet Film Thickness To Assure Conformance With Manufacturer's Requirements To Achieve Dry Film Thickness Per specs.					field report	<input checked="" type="checkbox"/>
115000						
Equipment Responsibility						
Hold Preinstallation meeting as specified					Meeting Minutes	<input checked="" type="checkbox"/>

Commissioning Items by CSI Division	Verified by:		Date compl	Coord Initial	Documentation Required	Owner Witness Required
	Name	Firm				
134906						
MRI-Magnetic Shielding						
Perform Tests Section of spec.					Test Report	<input checked="" type="checkbox"/>
134942						
Radio Frequency Shielded Enclosures						
Perform Tests Section of spec.					Test Report	<input checked="" type="checkbox"/>
200800						
Seismic Protection						
Perform Field Quality Control section of specifications					Test Report	<input checked="" type="checkbox"/>
Provide Extra Materials as specified					Transmittal	<input checked="" type="checkbox"/>
211313						
Wet-Pipe Sprinkler Systems						
Flush, test and inspect sprinkler piping per specifications paragraph					test report	<input checked="" type="checkbox"/>
Perform Systems Cleaning and Testing section of specifications					NFPA 13 Certification	<input checked="" type="checkbox"/>
Provide Extra Stock as specified					Transmittal	<input checked="" type="checkbox"/>
220500						
Basic Plumbing Materials and Methods						
Hold MEP pre-installation meeting(s).						<input type="checkbox"/>

Commissioning Items by CSI Division		Verified by:		Date compl	Coord Initial	Documentation Required	Owner Witness Required
		Name	Firm				
220523							
Valves							
Check valves for leaks and replace in necessary							<input type="checkbox"/>
220700							
Plumbing Pipe Insulation							
Perform Field Quality Control section of specifications						Test Report	<input checked="" type="checkbox"/>
Verify all valve stems are extended and accessible							<input type="checkbox"/>
221116							
Domestic Water Piping							
Flush, chlorinate, and reflush the potable water system. Take water sample at farthest point in system and perform test by approved lab. Per disinfection of domestic water piping system section of spec						test report from water testing lab	<input checked="" type="checkbox"/>
Perform Field Quality Control section of specifications						Test Report	<input checked="" type="checkbox"/>
221119							
Domestic Water Piping Specialties							
Perform Field Quality Control section of specifications						Test Report	<input checked="" type="checkbox"/>
221316							
Sanitary Waste and Vent Piping							
Perform Field Quality Control section of specifications						Test Reports	<input checked="" type="checkbox"/>

Commissioning Items by CSI Division		Verified by:		Date compl	Coord Initial	Documentation Required	Owner Witness Required
		Name	Firm				
221413							
Storm Drainage Piping							
Perform Field Quality Control section of specifications						Test Reports	<input checked="" type="checkbox"/>
226113							
Compressed-Air Piping for Laboratory and Healthcare Facilities							
Ensure piping is identified per specifications							<input type="checkbox"/>
Perform Field Quality Control section of specifications						Test Report	<input checked="" type="checkbox"/>
226213							
Vacuum Piping for Laboratory and Healthcare Facilities							
Perform Field Quality Control section of specifications						Test Report	<input checked="" type="checkbox"/>
226313							
Gas Piping for Laboratory and Healthcare Facilities							
Perform Demonstration section of specifications						Sign-In Sheet	<input checked="" type="checkbox"/>
Perform Field Quality Control section of specifications						Test Report	<input checked="" type="checkbox"/>
230500							
Basic Mechanical Materials and Methods							
Hold MEP pre-installation meeting(s).						Meeting Minutes	<input checked="" type="checkbox"/>

Commissioning Items by CSI Division	Verified by:		Date compl	Coord Initial	Documentation Required	Owner Witness Required
	Name	Firm				
230513						
Motors						
Verify basic motor requirements are in accordance with documents						<input type="checkbox"/>
Verify proper rotation and amp draw					Test Report	<input checked="" type="checkbox"/>
230519						
Meters and Gages						
Install test plugs where specified and at owner representative directive						<input type="checkbox"/>
230548						
Vibration and Seismic Controls for HVAC						
Perform Field Quality Control section of specifications					Test Report	<input checked="" type="checkbox"/>
230594						
Testing, Adjusting, and Balancing						
Coordinate and cooperate with owner's commissioning efforts						<input type="checkbox"/>
Coordinate temperature control testing and adjusting with temperature controls contractor						<input type="checkbox"/>
Ensure pre-test requirements as specified in paragraph 1.02 have been completed						<input type="checkbox"/>
Hold Pre Balancing Conference as specified					Meeting Minutes	<input checked="" type="checkbox"/>

Commissioning Items by CSI Division	Verified by:		Date compl	Coord Initial	Documentation Required	Owner Witness Required
	Name	Firm				
230700						
Mechanical Insulation						
Verify fire rating at fire dampers,walls, floors, ceilings and roof						<input type="checkbox"/>
Verify proper insulation used for piping and duct work						<input type="checkbox"/>
230900						
Control Systems						
Check and record amp draw on supply transformers of I/O panels					Test Report	<input checked="" type="checkbox"/>
Ensure shipping material has been removed from thermostats and other control devices						<input type="checkbox"/>
Post laminated control diagram in mechanical room						<input type="checkbox"/>
Verify all field devices provided by contractor are terminated						<input type="checkbox"/>
232113						
Hydronic Piping						
Perform Field Quality Control section of specifications					Test Report	<input checked="" type="checkbox"/>
Pressure test piping per testing piping section of specifications					test report	<input checked="" type="checkbox"/>
Provide Extra Materials as specified					Transmittal	<input checked="" type="checkbox"/>
Remove and clean all strainers after flushing system					Flush Report	<input checked="" type="checkbox"/>

Commissioning Items by CSI Division		Verified by:	Date compl	Coord Initial	Documentation Required	Owner Witness Required
		Name	Firm			
232213						
Steam and Condensate Piping						
Flush systems until strainers are clean, change strainers and clean vents					Flush Report	<input checked="" type="checkbox"/>
Perform Field Quality Control section of specifications					Test Report	<input checked="" type="checkbox"/>
233113						
Metal Ducts						
test for duct leakage per spec. Ducts shall meet leakage requirement prior to testing and balancing. Leakage Class of 4 if no other specified					Test Report	<input checked="" type="checkbox"/>
233300						
Duct Accessories						
Demonstrate Proper Operation of All Fire Dampers per NFPA-90A					Fire Damper Report	<input checked="" type="checkbox"/>
Perform Field Quality Control section of specifications					Test Report	<input checked="" type="checkbox"/>
233600						
Air Terminal Units						
Perform Field Quality Control section of specifications					Test Report	<input checked="" type="checkbox"/>
238123						
Computer-Room Air-Conditioning Systems						
Perform Demonstration section of specifications					Sign-In Sheet	<input checked="" type="checkbox"/>
Perform Field Quality Control section of specifications					field report	<input checked="" type="checkbox"/>

Verified by:						
Commissioning Items by CSI Division	Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
Provide Extra Material as specified					Transmittal	<input checked="" type="checkbox"/>
238413						
Humidifiers						
Perform Demonstration section of specifications					Sign-in Sheet	<input checked="" type="checkbox"/>
Perform Field Quality Control section of specifications					Test Report	<input checked="" type="checkbox"/>
Provide Extra Material as specified					Transmittal	<input checked="" type="checkbox"/>
260500						
Common Work Results for Electrical						
Perform Field Quality Control Section of specifications					Test Report	<input checked="" type="checkbox"/>
Perform System Commissioning Section of specifications					Commissioning Report	<input checked="" type="checkbox"/>
260519						
Conductors and Cables						
Ensure wires are color coded per specifications						<input type="checkbox"/>
Perform independent tests per "Field Quality Control" section of spec, including megohm/high pot tests					test report	<input type="checkbox"/>
260526						
Grounding and Bonding						
Perform independent tests per "Field Quality Control" section of spec, including megohm/high pot tests					test reports	<input checked="" type="checkbox"/>

Commissioning Items by CSI Division	Verified by:		Date compl	Coord Initial	Documentation Required	Owner Witness Required
	Name	Firm				
260536						
Cable Trays						
Perform independent tests per "Field Quality Control" section of spec, including megohm/high pot tests					test report	<input checked="" type="checkbox"/>
260553						
Identification for Electrical Systems						
Verify all equipment, panels, conduits and conductors are correctly labeled.						<input type="checkbox"/>
260573						
Power System Studies						
Factory certified technician to set electronic overcurrent devices to approved coordination study setpoints					Inspection Report	<input checked="" type="checkbox"/>
Place arflash labels on equipment as specified						<input checked="" type="checkbox"/>
SKM data to be e-mailed to MU Commissioning Engineer					SKM Data	<input checked="" type="checkbox"/>
Train owners representatives in setting of overcurrent devices					Sign-up Sheet	<input checked="" type="checkbox"/>
260923						
Lighting Control Devices						
Perform "Demonstration" section of spec.					Sign-In Sheet	<input checked="" type="checkbox"/>
Perform independent tests per "Field Quality Control" section of spec.					field report	<input checked="" type="checkbox"/>

Commissioning Items by CSI Division		Verified by:		Date compl	Coord Initial	Documentation Required	Owner Witness Required
		Name	Firm				
262416							
Panelboards							
Perform checks per "Field Quality Control" section of spec						Test Report	<input checked="" type="checkbox"/>
Provide extra material (keys) as specified						Transmittal	<input checked="" type="checkbox"/>
262726							
Wiring Devices							
Perform checks per "Field Quality Control" section of spec						Test Report	<input checked="" type="checkbox"/>
Perform checks per spec						Test Report	<input checked="" type="checkbox"/>
262813							
Fuses							
Furnish Extra Materials as specified						Transmittal	<input checked="" type="checkbox"/>
265100							
Lighting							
Furnish Extra Material as Specified						Transmittal	<input checked="" type="checkbox"/>
Illuminate emergency lights for 90 minutes on battery power.						Test Report	<input checked="" type="checkbox"/>
Illuminate exit lights for 90 minutes on battery power.						Test Report	<input checked="" type="checkbox"/>
Perform tests per "Field Quality Control" section of spec						Test Report	<input checked="" type="checkbox"/>

Commissioning Items by CSI Division	Verified by:		Date compl	Coord Initial	Documentation Required	Owner Witness Required
	Name	Firm				
283111						
Digital, Addressable Fire-Alarm System						
Perform checks and acceptance tests per NFPA					NFPA Certification	<input checked="" type="checkbox"/>
Precheck all fire alarm devices					Precheck Checklist	<input type="checkbox"/>
Provide factory training per system training section of spec.					Sign in sheet	<input checked="" type="checkbox"/>
Verify operation of each notification device						<input checked="" type="checkbox"/>
Verify room sensors labeled						<input type="checkbox"/>
Verify smoke dampers installed						<input type="checkbox"/>

Please see following website for suggested commissioning forms:

<https://operations.missouri.edu/facilities/commissioning-forms>

SECTION 1.F

INDEX OF DRAWINGS

Drawings referred to in and accompanying Project Manual consist of following sheets **dated**.

Architectural

- A0.0 Cover
- A0.1 General Information & Abbreviations
- A0.2 Typical Mounting Heights
- A0.3 First Floor Life Safety Plan
- A0.4 First Floor Construction Access Plan
- A0.5 Phasing Plans
- A0.6 UL Details
- AD2.1 First Floor – Demolition Plan & Notes
- AD3.0 Ground & First Floors – Area of Disturbance Plans
- A2.1 First Floor – New Work Floor Plan & Notes
- A2.2 Roof Level Plan & Notes
- A4.1 North Elevation/Details
- A5.1 Schedules & Partition Types & Details
- A5.2 Door Schedule & Details
- A5.3 Finish Floor Plan
- A6.1 First Floor – New Work Reflected Ceiling Plan & Notes
- A8.1 Interior Elevations
- A8.2 Interior Elevations
- A8.3 Interior Elevations
- A9.1 Interior Details
- A11.1 First Floor Equipment Plan & Schedule
- A12.1 RF Shielding Plans/Elevations
- A12.2 RF Shielding Details
- A12.3 RF Shielding Details
- A13.1 Magnetic Shielding Plans & Sections

Mechanical

- M0.0 Mechanical Symbols & Abbreviations
- M1.1 Mechanical First Floor Demo Plan
- M2.1 Mechanical First Floor Duct New Work Plan
- M-2.1A Mechanical First Floor Piping New Work Plan
- M-3.0 Mechanical Piping Diagrams
- M-5.0 Mechanical Details
- M-5.1 Mechanical Details
- M-6.0 Mechanical Schedules
- M-7.0 Mechanical Controls

Plumbing

- P0.0 Plumbing Symbols and Abbreviations
- P1.1 Plumbing First Floor Demo Plan
- P1.2 Plumbing Ground Floor Demo Plan
- P1.3 Plumbing Medical Gas First Floor Demo Plan – New Work

- P2.1 Plumbing First Floor New Work Plan
- P2.2 Plumbing Medical Gas First Floor New Work Plan
- P2.3 Plumbing Ground Floor New Work Plan
- P2.7 Plumbing Details and Schedules

Fire Protection

- P0.0 Fire Protection Symbols and Abbreviations
- FP1.1 Fire Protection First Floor Demo Plan
- FP2.1 Fire Protection First Floor New Work Plan
- FP2.7 Fire Protection Details

Electrical

- E0.1 Electrical Legend
- E0.2 Electrical Key Plan
- E1.1 Fire Alarm First Floor Demo Plan
- E1.2 Lighting First Floor Demo Plan
- E1.3 Power First Floor Demo Plan
- E2.1 Fire Alarm First Floor New Work Plan
- E2.2 Lighting First Floor New Work Plan
- E2.3 Power First Floor New Work Plan
- E2.4 Power Roof Plan
- E2.5 Siemens Equipment Plan New Work
- E5.1 On-Line Diagram
- E6.1 Details and Schedules
- E6.2 Details and Schedules
- E6.3 Details and Schedules
- E6.4 Details and Schedules
- E6.5 Details and Schedules.

END OF SECTION

(a)

SECTION 1.G

PREVAILING WAGE RATES

[The rates will be supplied to the Consultant in packet immediately before project is advertised.]

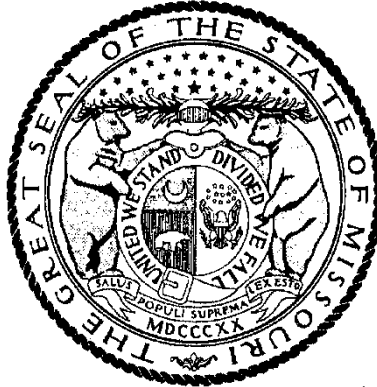
END OF SECTION

(b)

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.

ALTERNATES (NOT USED)

1.E.1
Healthcare Construction Guideline
October 2023 Edition

Table of Contents

1.	CONTRACTOR ORIENTATION	2
	REQUIRED TRAINING	2
	TRAINING AGENDA	ERROR! BOOKMARK NOT DEFINED.
2.	EMERGENCY CONTACT INFORMATION & PHONE NUMBERS	2
3.	CONTRACTOR IDENTIFICATION BADGE	2
	CONTRACTOR ID BADGE	2
4.	GENERAL REQUIREMENTS FOR HEALTH CARE PROJECTS	3
5.	CONSTRUCTION-RENOVATION-MAINTENANCE RISK ASSESSMENT (CRMRA)	3
6.	CONSTRUCTION/RENOVATION/MAINTENANCE INFECTION CONTROL RISK MITIGATION CRITERIA	3
7.	CONSTRUCTION BARRIERS	4
8.	VENTILATION AND NEGATIVE AIR REQUIREMENTS	4
9.	ICRM EQUIPMENT AND PRODUCT INFORMATION	5
10.	ALTERNATE LIFE SAFETY MEASURES ASSESSMENT (ALSM)	7
11.	NOISE AND VIBRATION CONTROL MANAGEMENT	7
12.	ABOVE CEILING WORK	7
13.	UTILITY SYSTEMS SHUTDOWN & SERVICE PERMIT	8
	UTILITY OUTAGE	8
	UTILITY SERVICE	8
	ELECTRICAL SAFETY	8
14.	HOT WORK & PERMIT	8
15.	HELICOPTER APPROACH/TAKE-OFF	9
16.	REQUIRED FORMS, PERMITS, POSTINGS AND DOCUMENTATION	10
17.	HEALTH CARE CONSTRUCTION CLEANING DEFINITIONS	11
	CONSTRUCTION CLEAN (CONTRACTOR RESPONSIBILITY)	11
	THOROUGH CLEAN (CONTRACTOR RESPONSIBILITY)	11
	TERMINAL CLEAN (OWNER RESPONSIBILITY)	11
	FIGURE 1 NEGATIVE AIR PRESSURE AND FILTER CHANGE LOG	12
	FIGURE 2 EXAMPLE CONTRACTOR BADGE	13
	FIGURE 3 EMEDITRACK REQUEST CHECKLIST	14
	FIGURE 4 – ABOVE CEILING INSPECTION CRITERIA (MINIMAL, DUST PRODUCING) ICRA - PROTOCOL	17
	FIGURE 5 – INFECTION CONTROL CONTRACTOR CHECK LIST	19
	FIGURE 6 – REQUEST FOR OUTAGE	20
	FIGURE 7 – CONTRACTOR-VENDOR ACKNOWLEDGEMENT OF ELECTRICAL SAFETY REQUIREMENTS TRAINING	21

1. Contractor Orientation

The purpose of Contractor orientation is to ensure that project work in and around the healthcare environment is managed in such a way to minimize health and safety risks associated with construction activities.

Required Training

1. Project managers, superintendents and subcontractor foremen assigned to the project will be required to attend a minimum of one (1) hour training session related to “Infection Control & Dust Barriers” and “Healthcare Construction Training for Contractors”. Training will be conducted by MUHC personnel and must be scheduled in advance.
2. Individuals that receive training will be required to sign their name on a training acknowledgement form stating that they have been oriented to the training requirements.
3. Project managers, superintendents and subcontractor foremen have the responsibility for ensuring that Contractor employees and subcontractor trade workers are knowledgeable of the training requirements and direct their employees and manage their work accordingly.

2. Emergency Contact Information & Phone Numbers

Contractor shall provide list of emergency contacts and phone numbers for individuals responsible for responding to emergency situations which may occur 24/7.

Contact list to be included as a topic of discussion during the Pre-Construction Meeting and included in the meeting minutes.

Emergency contact list must be posted inside project entry door(s) for the duration of project.

3. Contractor Identification Badge

Contractor employees and subcontractor trade workers working on the project are required to wear a “Contractor Identification Badge” as outlined below.

Contractor ID Badge

1. Contractor shall produce ID badges for all its employees and subcontractor trade workers conducting work on an MUHC job site. It is the responsibility of the Contractor to provide the computer and color printer for reproduction of badges required. Consult the Owner’s Representative for the electronic file. (Contractor to validate employee with proof of ID).
2. Contractor to edit the information, print in color, cut out the badges, fold in the center and insert in Contractor provided badge holders.
3. Contractor shall keep a log of badged employees by trade/subcontractor at the jobsite for reference by the Owners Representative.
4. Contractor employees are to wear the badge on the upper chest facing forward unless approved otherwise for safety reasons.
5. Project Managers, superintendents, and subcontractor foreman shall attend “Healthcare Construction Training” and affix issued “T” sticker in the circle area on badge as shown. This will show evidence that the employee has completed training. All badges to be collected by the Contractor and disposed of at the end of the project.
6. See Figure 2, Section 1.E. for “Example Contractor Badge”.

4. General Requirements for Health Care Projects

The Contractor is responsible for understanding, planning and implementing the following requirements in the management of the project.

1. On-site worker clothing must be clean and free of holes or fraying.
2. On-site workers shall be fitted with a Contractor furnished shirt containing company name and logo.
3. On-site worker shoes/boots must be free of dirt/debris before entering and leaving the construction area.
4. If track-out occurs in an occupied area of the healthcare facility, you must stop and clean immediately by using a HEPA filtered vacuum and/or a clean dampened floor mop with a MUHC approved cleaning solution. All cleaning solutions must be approved by the Owner.
5. Assure that all construction material, equipment and tools are cleaned and covered with a clean cloth while transporting through the healthcare facility.
6. Ensure that wheels on delivery and trash carts are clean before leaving the construction area.
7. Patients, visitors, and staff ALWAYS have priority and the “Right of Way” in the elevators and corridors.

5. Construction-Renovation-Maintenance Risk Assessment (CRMRA)

The “Construction-Renovation-Maintenance Risk Assessment” (CRMRA) planning process establishes criteria and measures to protect patients, visitors and staff from construction activities that could lead to infections or impact life safety systems in the healthcare facility.

[Facility – Construction, Renovation, Maintenance Risk Assessment – Policy](#)

The Owner’s Representative will work with the Contractor to coordinate and facilitate these CRMRA planning activities with MUHC Engineering Services, Infection Control Department and others as required during the duration of the project.

See Figure 3, Section 1.E. for a copy of the “*eMeditrack Assessment Checklist*”.

6. Construction/Renovation/Maintenance Infection Control Risk Mitigation

Criteria

The “Construction–Renovation-Maintenance Infection Control Risk Mitigation Criteria” (CRMICRMIC) is a process to evaluate projects for required interventions during construction. The goals are to minimize Hospital Acquired Infections (HAI’s) and control dispersal of air/water-borne infectious agents concealed within the building components.

All construction activities shall be defined and managed in such a way that exposure to dust, moisture, and accompanying hazards are mitigated.

1. Any work done outside the main project limits will require a NEW Infection Control Risk Assessment. See Figure 3, Section 1.E. for a copy of the “*eMeditrack Assessment Checklist*”.
2. The Owner’s Representatives and Contractor will work together to coordinate the assessment and determine if MUHC permits (hot work, energized work, above ceiling, etc.) and associated requirements are needed.
3. The Owner’s Representative will ensure that all required infection control interventions and life safety measures required for the project are in place by the Contractor prior to starting work. (i.e., barrier walls, tacky mats, required exits, etc.)
4. The Contractor shall follow all requirements to support the “Construction – Renovation-Maintenance Infection Control Risk Mitigation Criteria”.

5. CRMIC Permit will provide requirements specific to the project.
6. See Figure 5, Section 1.E. for a copy of the “Infection Control Contractor Check List”, utilized as a tool to aid understanding of good infection control processes through various phases of construction.
7. On-site workers that violate the requirements of the “Construction – Renovation-Maintenance Infection Control Risk Mitigation Criteria/Permit” will be removed from the project.

7. Construction Barriers

To protect patients, visitors, and staff from construction dust, fumes, and other exposures, an isolation barrier with or without negative air may be required to be established before construction activities may begin. Barriers are meant to strictly delineate the work area. When necessary, construction barriers will be called out by Infection Control in the Infection Control Risk Mitigation Criteria (ICRMC).

1. A copy of the ICRMC describing barrier requirements shall be visibly posted on the barrier of the work area for the duration of the project.
2. Required barriers may include one or more of the following:
 - a. Existing wall assemblies;
 - b. Rooms with doors that separate from adjacent spaces;
 - c. Commercial rigid construction barrier assemblies;
 - d. Constructed stud and wall board walls;
 - e. Fire-resistant 6-mil polyethylene sheeting; or
 - f. Portable containment units / HEPA carts.
3. Contractors are responsible for:
 - a. Ensuring barriers are properly constructed and maintained for the duration of the project;
 - b. Keeping the exterior of the barrier clean and free of damage;
 - c. Securing entrances through the barrier to the work site (doors, zippers, etc.)
 - d. Posting and maintaining signage on the barriers to
 - i. Indicate “Construction Area, Authorized Personnel Only”; and
 - ii. directional for staff and patient traffic, when necessary.
 - e. Ensure that barrier entrances are kept closed and always secured.
4. Upon installation of barriers, before beginning work, the Contractor shall notify the Owner’s Representative to coordinate an inspection. The Infection Control in the Infection Control Risk Mitigation Criteria (ICRMC) requires approval from Infection Control before beginning work.
5. Upon the completion of work, the Contractor shall notify the Owner’s Representative to coordinate the removal of barriers. The Infection Control in the Infection Control Risk Mitigation Criteria (ICRMC) requires approval from Infection Control before removing barriers.

8. Ventilation and Negative Air Requirements

Establishing negative air means that the area under construction is negative relative to surrounding areas; this pressure difference prevents dust, fumes, and airborne contaminants and pathogens from escaping the construction area. When necessary, negative air requirements will be called out by Infection Control in the Infection Control Risk Mitigation Criteria (ICRMC).

1. A copy of the ICRMC describing negative air requirements shall be visibly posted on the barrier of the work area for the duration of the project.
2. Negative air requirements may include one or more of the following:
 - a. HEPA-filtered negative air ventilation units
 - i. Exhausted directly outside;
 - ii. Exhausted into an adjacent space or corridor;
 - iii. Recirculating (scrubbing) air within the work area; or
 - iv. Integrated into portable containment units / HEPA carts.
3. Negative air pressure may not:
 - a. Be achieved by using filtered HVAC air returns in any room, including isolation rooms; or
 - b. Be exhausted into the HVAC system unless it is a portion of the exhaust that leads directly outdoors.
4. Contractors are responsible for:
 - a. Sealing all HVAC supply and returns within the work area.
 - i. Maintaining these seals may require Engineering Services to close dampers or disconnect ducts serving the work area.
 - b. Regular maintenance of HEPA-filtered negative air ventilation units;
 - c. Regularly cleaning prefilters and filters;
 - d. Furnishing and installing a manometer on the outside of the barrier;
 - e. Ensuring that negative air pressure in the work area is at least -0.01 inches of water column (WC);
 - f. Daily documentation of the negative air pressure on the "Negative Air Pressure and Filter Change Log," posted next to the manometer.
 - i. Logs will be collected by Infection Control at completion of the project.
 - ii. See Figure 1, Section 1.E. for a copy of the "Negative Air Pressure and Filter Change Log".
5. If the installation of a barrier is also required, the negative air units should be turned on before barrier construction begins.
6. Once negative air units are in place, the Infection Control in the Infection Control Risk Mitigation Criteria (ICRMC) may require approval from Infection Control before beginning work.
7. Upon the completion of work, barriers should be removed before negative air units are removed; the Infection Control in the Infection Control Risk Mitigation Criteria (ICRMC) may require approval from Infection Control before the removal of negative air units.

9. ICRM Equipment and Product Information

Approved Equipment and Product Information

RIGID BARRIER SYSTEMS

- Lightweight modular wall system that meets or exceeds ICRA Class IV and ASTM E84 requirements. STARC Systems, (844)596-1784
- RealWall for sound attenuating and noise control.
- LiteBarrier sensitive patient occupied areas.
- FireblockWall for One-hour Fire-rated containment.
- Or approved equal.

NEGATIVE AIR HEPA FILTERED VENTILATION UNIT

- HEPA filter equipped negative air machines that provide rough in filters, primary filters and a HEPA final filter.
- Rating of 300 to 2000 cubic feet per minute, (CFM).
- HEPA filters must be a minimum 99.97% efficient @ 0.3 microns.
- Differential pressure alarm required if not installed in another fashion to monitor construction site negative air of – 0.01 water column. Or approved equal.
- MICRO Trap Corporation, Models MT 1000 or Model MT 2000. 1300 W. Steel Road, No. 2 Morrisville, PA 19067 (215) 295-8208 or (877) 646-8208.
- ABATEMENT Technologies, Inc. Model HEPA-AIRE PAS2400HC Portable Air Scrubber or Model PAS1200HC 605 Satellite Blvd. Suite 300 Suwanee, GA 30024 (800) 634-9091
- Or approved equal.

HEPA VACUUM

- Shop style vacuum with HEPA filter cartridge at 99.97% filtration @ 0.3 microns. Or approved equal.
- ABATEMENT Technologies Inc. Model V8000WD Canister Style Wet/Dry HEPA Vacuum. 605 Satellite Blvd. Suite 300 Suwanee, GA 30024 (800) 634-9091.
- ABATEMENT Technologies Inc. Model V1300H Hip Mounted HEPA Vacuum, designed for use on scaffolding and mobile conditions such as ceiling tile type cleaning. Lightweight at 6.4 lbs.
- 605 Satellite Blvd. Suite 300 Suwanee, GA 30024 (800) 634-9091.
- Or approved equal.

ADHESIVE WALK OFF MATS

- 24" x 36" Tacky Mat.
- Peel up dirty layer and dispose to reveal a new, fresh clean tacky mat.
- Tacky walk off mat No. 5838 24" x 36", 60 tacky mats to a unit. Four units per case.
- 3M Company, St. Paul, MN 55144 (888) 364-3577.
- Or approved equal.

NEGATIVE AIR PRESSURE INDICATOR

- Manometer.
- Model "Mark II Model No. 25 inclined-vertical Manometer. Dwyer Instruments Inc. PO Box 373, Michigan City, IN 46361 (219) 879-2000.
- MICRO Trap Corporation, Model Tri/Mon, digital recording manometer for tracking differential pressure.
- Contact info: 1300 W. Steel Road, No. 2 Morrisville, PA 19067 (215) 295-8208 or (877) 646-8208.
- Or approved equal.

PORTABLE WORK ENCLOSURE

- For temporary fire-resistant polyethylene dust barrier.
- System components supplier of zip poles, door opening access zippers, dust sealing system parts, etc.
- Contact info: Zip Wall, LLC. 37 Broadway, Arlington, MA 02474 (800) 718-2255.
- Or approved equal.

FIRE RESISTANT POLYETHYLENE

- For temporary dust barriers and use with Zip Wall Barrier System.
- Fire resistant polyethylene 6 mil.
- Underwriters Laboratories listed.

- Americover, Inc. 6 mil. Fire Retardant Polyethylene No. ASFR6. Use with Zip Pole System also sold by Americover.
- Contact Info: 2067 Wineridge Place. Suite F Escondido, CA 92029. 800-747-6095 Dept. 48.
- Or approved equal.

10. Alternate Life Safety Measures Assessment (ALSM)

Alternate Life Safety Measures (ALSM) are a series of administrative actions that must be taken to compensate temporarily for the hazards posed by existing NFPA Life Safety Code 101, 2012 edition deficiencies, other building code issues or construction activities. Examples of construction activities that require ALSM's to be implemented are as follows:

1. Fire alarm system, detection, and/or sprinkler system are impaired or disabled.
2. Normal exits or exit routes and/or exit lighting have been compromised.
3. Re-routing of traffic due to construction activities.
4. Temporary narrowing of the corridor.
5. Deficiencies in fire and/or smoke separations and systems caused by construction activities. (Changes to wall, door, dampers, penetrations, etc.)
6. Emergency lighting not compliant.
7. Major and minor construction/renovation in an occupied health care occupancy.
8. Hot work.
9. Impairment or shutdown of a fire sprinkler system or fire alarm system for a period of 4 hours or longer in a 24-hour period.

Whenever an ***“Alternate Life Safety Measure”*** is identified for implementation during the construction project, there will typically be measures or actions required by both the MUHC Engineering Services department and the Contractor.

Prior to the beginning of work and throughout the project, the Contractor must be familiar with the ALSM to plan and identify construction related activities that will require an evaluation of ALSM's as noted in the ALSM. The ***“Alternate Life Safety Measures Evaluation”*** is a required team effort.

11. Noise and Vibration Control Management

Construction related noise/vibration control and mitigation measures are to be implemented when the Contractor is working in and around healthcare facilities. The Contractor shall work with the Owner's Representative to develop means and methods for controlling excessive noise and vibration during construction.

12. Above Ceiling Work

Access to areas above the ceiling must be coordinated with the Owner's Representative. Depending upon the location and purpose of accessing areas above the ceiling, the Contractor may need to follow a standing protocol or obtain an *Above Ceiling Work Permit*.

1. Standing protocol
 - a. Above Ceiling Inspection Criteria / Minimal Dust Producing Protocol
 - i. To be used for visual inspection of mechanical, electrical, plumbing, structural components.
 - ii. May be used with fireproofing and VAV damper adjustment.
 - iii. Applies to all contractors, and vendors.

- iv. See Figure 4, Section 1.E. for a copy of the “Infection Prevention & Control Program – Above Ceiling Inspection Criteria (Minimal, Dust Producing) ICRA – Protocol”.
2. Above Ceiling Work Permit
 - a. Must be requested for
 - i. Any cable or wiring pulls through the healthcare facility.
 - ii. Other above ceiling work beyond the scope of visual inspection.
 3. Contractors are responsible for:
 - a. Notifying the Owner’s Representative three (3) business days prior to the need for above ceiling access.
 - b. Replacing ceiling tiles as soon as possible. Displaced ceiling tiles shall not be left unattended in areas not contained by a construction barrier.
 - c. Notifying the Owner’s Representative to acquire replacement ceiling tiles if they are damaged during work.

13. Utility Systems Shutdown & Service Permit

“Utility Systems” shall be defined as any system that would hinder the delivery of patient care and hospital operations should the system be interrupted for any reason. Planning for this work usually requires a contingency plan by the healthcare facility management department to address any failure of the utility system.

See Figure 6, Section 1.E for “Request for Outage” form.

Utility Outage

Utility or system connections, shut offs, or interruptions must be scheduled with the Owner’s Representative prior to commencement of the work. This work shall be defined as either a “Planned” or “Unplanned Utility Outage” and notice shall be made to the Owner’s Representative to coordinate the request and facilitation.

Utility Service

In addition to utility system connection, shut-off, or interruption, the Contractor must also schedule any work on existing utility systems that either do not require interruption or cannot be interrupted to accomplish the work. This type of work shall be defined as “Utility Service” and notice shall be made to the Owner’s Representative. The Contractor shall give up to 14 calendar days’ notice to the Owner’s Representative to properly plan and coordinate required activities.

Electrical Safety

In accordance with National Fire Protection Association (NFPA) 70E, *Standard for Electrical Safety in the Workplace*, MUHC requires all contractors and service personnel performing services on MUHC owned or managed properties to always comply with OSHA and NFPA 70E (current edition).

The contractor shall complete the “Contractor/Vendor Acknowledgement of Electrical Safety Requirements & Training” form before mobilizing to the site, see Figure 7, Section 1.E.

14. Hot Work & Permit

Hot Work shall be defined as welding, brazing, cutting soldering, grinding, or other flame or sparking producing activities which are capable of initiating fires or explosions.

All Contractors performing construction activities in MUHC Facilities are required to follow the requirements and provisions of *NFPA 51B – 2019* and the Owner’s Representative procedures related to Hot Work.

The following are the requirements for a Contractor to obtain a “*Hot Work Permit*”:

1. Contractors shall contact the Owner’s Representative prior to requesting a “*Hot Work Permit*”.
2. Hot work permit requests for complex projects requiring extensive planning on behalf of the Owner and Owner’s Representative may require several days’ notice.
3. MUHC Engineering Services will issue a “*Hot Work Permit*” to be posted in the vicinity of the hot work being performed. Upon completion, the hot work permit shall be returned to MUHC Engineering Services.
4. All hot work sites are inspected by the Owner using the requirements printed on the hot work permit.
5. Hot work permits are issued for each work shift unless other arrangements have been made with Owner’s Representative.
6. If hot work cannot be completed within one work shift, the Contractor is responsible for obtaining approval for a revised permit extension from MUHC Engineering Services. The Contractor is responsible for meeting all safety requirements required by the permit for any extensions granted.
7. The Contractor shall be responsible for supplying a trained fire watch for the duration of hot work, including during lunch and/or scheduled breaks, with no other assigned duties. **The fire watch’s only responsibility will be as a fire watch.**
8. All permits require a 1-hour fire watch following completion of hot work activity.
9. Contractor shall provide at a minimum a ten-pound (10) ABC fire extinguisher that has a current, valid inspection tag at each hot work location.
10. A copy of the “*Hot Work Permit*” shall be kept in the general Contractor’s project file for future review as may be required.

15. Helicopter Approach/Take-off

Construction related activities on the hospital’s grounds, property, or building roofs must follow the guidelines regarding construction activities during helicopter landings and take-offs at the helipad. The Contractor shall coordinate the following with the Owner’s Representative:

- Roof access
- Roof protection
- Air care traffic safety precautions to be taken when conducting work on roofs.
- In addition, the placement of vertical installations such as tall lighting poles and the use of project cranes or hoisting on the hospital property might affect the “Approach and Take Off” of air care traffic. It is essential that the Contractor coordinate these types of activities in advance with the Owner’s Representative prior to the beginning of work.

16. Required Forms, Permits, Postings, and Documentation

Note: Refer to sections within the “Healthcare Construction Guideline” for detailed information on each form and permit approval procedure.

Category	Required Notice	Form	Permit Approval	Job Site Posting	Contractor Safety File
CRM Infection Control Construction Permit	Before Starting	√	√	√	√
Above Ceiling Permit	14 Days	√	√	√	√
Utility Systems Shutdown & Service Permit	14 Days	√	√	√	√
Fire Protection System Impairment Permit	14 Days	√	√		√
Hot Work Permit	2 Days	√	√	√	√
Lock Out/Tag Out Permit	14 Days	√	√	√	√
CRM Alternate Life Safety Measures Assessment		√			
Negative Air Pressure Log		√		√	√
CRM Risk Assessment		√			
Construction Safety Deficiency Notice		√			√
Violations and “Notice to Contractor”		√			√
Hazardous Material Abatement Signage				√	
Required Construction Jobsite Signage				√	
Alternate Life Safety Signage				√	
Contractor & Employee Training Acknowledgment		√			√
Contractor Safety Meeting Minutes					√

The Contractor will be required to furnish and install a “Project Safety Information” bulletin board on their project site for posting of required safety information. Small, short duration projects may have this requirement waived by the Owner’s Representative.

LEGEND CRM = Construction-Renovation-Maintenance

17. Health Care Construction Cleaning Definitions

Construction Clean (Contractor Responsibility)

1. Remove construction materials, tools, and equipment from the work area.
2. Remove all trash from the work area.
3. Thoroughly sweep all floor surfaces in the work area utilizing a dust compound (floor sweep) material.
4. Dry wipe all horizontal & vertical surfaces in the work area. Surfaces to include but not limited to walls, windowsills, doors & door frames, base trim, casework (inside & out), fixtures, and wall mounted equipment.
5. Sweep all floor surfaces utilizing a dust mop.
6. Wet mop all floor surfaces.

Thorough Clean (Contractor Responsibility)

1. To be implemented only after Construction Clean procedures have been completed.
2. Wet wipe all horizontal and vertical surfaces utilizing a MUHC – Infection Control Department approved germicidal disinfectant. Surfaces to include but not limited to walls, windowsills, doors & door frames, base trim, casework (inside & out), all fixtures, and wall-mounted equipment.
3. Wet mop all floor surfaces utilizing a MUHC Infection Control Department approved germicidal disinfectant.

Terminal Clean (Owner Responsibility)

1. To be implemented only after Through Clean procedures have been completed.
2. Cleaning procedures shall be conducted by MUHC trained Environmental Services, Sterile Processing or Surgical Services staff only.
3. Thoroughly clean and disinfect surfaces on the ceiling such as diffusers, light fixtures, and ceiling mounted devices & equipment.
4. Thoroughly clean and disinfect all equipment in the work area.
5. Thoroughly clean and disinfect all flooring including moving equipment & furnishings to allow access to all floor surfaces.
6. Move all portable equipment and furnishings away from the walls. Wet wipe and disinfect all wall surfaces and wall mounted equipment.

Figure 2 Example Contractor Badge

	
<p>Enter Name</p>	
<p>Enter Company Name</p>	
Project#:	Enter Project #
Project Name:	Enter Project Name
Expires:	Enter Expiration

	
<p>Enter Name</p>	
<p>Enter Company Name</p>	
Project#:	Enter Project #
Project Name:	Enter Project Name
Expires:	Enter Expiration

	
<p>Enter name</p>	
<p>Enter Company Name</p>	
Project#:	Enter Project #
Project Name:	Enter Project Name
Expires:	Enter Expiration

Protocol for Hospital Contractor Badges:

Contractor to issue badges to employees as necessary. (Need to show proof of ID)

Contractor to edit the information, print in color, cut out the badge, fold in the center and insert in badge holders.

Contractor shall keep a log of badged employees on site for reference by MU as necessary.

All permits to be collected and returned to MU at the end of the project.

Any orientation required will be discussed at the preconstruction meeting with the Owner's Representative.

Figure 3 eMeditrack Request Checklist

EMEDITRACK ASSESSMENT REQUEST ENTRY CHECKLIST			
Project Work Name			
Project#/Work Order #		Date of Request	
Trade/Vendor/Project Manager		Start Date	
Name:		End Date	
Email:			
Phone:			
Location of Work			
Building			
Floor			
Specific Site for Work – Be as specific as possible; include Room #'s			
Activity Scope and Comments			
File Upload – Insert up to four (4) documents			
--- IMPORT SPECIFIC PLANS ---			
Will this activity be dust generating? (if yes, comment with any mitigating efforts)	Y	N	N/A
Comments:			
Will any fire protection systems be impaired or be taken out of service?	Y	N	N/A
Comments:			
Will building access or egress be impaired?	Y	N	N/A
Comments:			
Will there be impediments to or corridor restrictions?	Y	N	N/A
Comments:			

Figure 3 eMeditrack Request Checklist (cont'd)

Will there be flammable hazards or increased combustible fuel loads in the activity area?	Y	N	N/A
Comments:			
Will the activity require "Hot Work"?	Y	N	N/A
Comments:			
Will existing horizontal or vertical fire or smoke barriers be breached?	Y	N	N/A
Comments:			
Will the activity require the use and/or storage of hazardous chemicals?	Y	N	N/A
Comments:			
Will there be HVAC modifications? (If so, required testing & balancing or recertification may be mandated)	Y	N	N/A
Comments:			
Will the activity require asbestos, lead, or mold abatement? (Please specify)	Y	N	N/A
Comments:			
Will the activity require confined-space entry?	Y	N	N/A
Comments:			
Will the activity require utility outages? (Electrical, domestic water, HVAC, med gas, sanitary sewer, steam, etc.)	Y	N	N/A
Comments:			
Will the activity generate noise or vibration levels that may affect patient safety?	Y	N	N/A
Comments:			
Will the activity require off-hours work?	Y	N	N/A


Figure 3 eMeditrack Request Checklist (cont'd)

Comments:			
Will modifications or additions to security technology be required? (Cameras, panic device, card access system, etc.)	Y	N	N/A
Comments:			
Will the work require hoisting of equipment and/or use of crane(s)?	Y	N	N/A
Comments:			
Will the work require the use of scaffolding?	Y	N	N/A
Comments:			
Will the work interrupt normal pedestrian or vehicular traffic?	Y	N	N/A
Comments:			
Will the work displace soiled linen or trash storage rooms?	Y	N	N/A
Comments:			
The information received in the PCRA will be included in the overall assessment. MUHC Infection Control completes the ICRA that designates installation of required construction or infection control barriers.			

Work request must be properly submitted and **APPROVED with documents issued via Soleran System** prior to commencement of building demolition, construction, renovation, planned system outages, and facility maintenance work. =

- Request shall be submitted as soon as possible to begin processing and allow full vetting.
- Submissions are preferred at minimum Three (3) working days prior to date for work to begin.
- No request will be approved with less than twenty-four (24) hours' notice unless approved by Executive Director of Support Services.

Figure 4 – Infection Prevention & Control Program - Above Ceiling Inspection Criteria (Minimal, Dust Producing) ICRA - Protocol

	Document Owner:	Last Approved Date:
	Kirsten Hann	04/11/2022
Content Expert:		
Cathy Schlotzhauer		Ref# 22516

Printed copies are for reference only. Please refer to the electronic copy for the latest version.

Purpose Statement

- a. To provide a process for ensuring a safe environment for patients, visitors and staff when undergoing construction.
 - b. The standardization of this protocol is to be used as the infection control risk assessment (ICRA) with interventions for planned or unplanned above ceiling access for inspection with minimal to no dust production.
- II. Definitions
- a. Above ceiling access protocol: should be utilized for inspections of VAV dampers, pipes, ceiling, cables; or fireproofing.
 - b. Work area: space directly below an open ceiling tile; encompasses a 6-foot radius.
 - c. Portable Containment Unit (PCU): mobile containment equipment with the ability to extend up to ceiling to seal off work areas to prevent the spread of dust.
 - d. Polyethylene sheeting: light plastic covering utilized to prevent contamination of stationary equipment during work periods. Removal involves folding the polyethylene into itself to reduce the risk of debris falling onto surfaces in the room/space. Contaminated polyethylene shall not be reused.
- III. For use by
- a. This protocol applies to all construction staff and outside vendors performing duties at University of Missouri Health Care facilities.
- IV. Content
- a. Non-Patient Care Areas (e.g., office, clinic off hours, electrical, mechanical rooms, corridor of ground floor at UH, corridors in non-patient care areas, cafeteria, chapel, lobbies).
 - i. May remove one tile at a time from the suspended ceiling system.
 - ii. Remove portable equipment/items from under the work area. Items that cannot be removed shall be covered with polyethylene sheeting.
 - iii. “Clean as you go” utilizing a HEPA filtered vacuum to clean up any debris.
 - b. Patient Care Areas (ex. General care units, diagnostic testing areas, emergency department, pharmacy)
 - i. There shall be no patient in the room/space. Off hours work may be warranted due to delays in access to the specific space.
 - ii. May remove one tile at a time from the suspended ceiling system.
 - iii. Remove portable equipment/items from the work area. Items that cannot be removed shall be covered with polyethylene sheeting.
 - iv. “Clean as you go” utilizing a HEPA filtered vacuum to remove tile debris.
 - c. Sub Sterile/Sterile Environment (e.g., Operating room, sterile processing, Intensive Care, procedure room, laboratory, and compounding pharmacy).
 - i. All work activities shall be conducted during off hours. The off hours are determined by individual departments and are subject to change.

- ii. All workers shall wear appropriate surgical attire. The attire includes disposable head cover, surgical mask for persons with facial hair, approved freshly laundered scrub suit for disposable surgical coverall, and shoe covers.
 - iii. May remove one tile at a time from the suspended ceiling system utilizing a portable containment unit (PCU) whenever possible. If the ceiling is too high or area too small for PCU, remove portable equipment/supplies from the work area. Items that cannot be removed shall be covered with polyethylene sheeting.
 - iv. Corridor doors adjacent to the work area shall be closed during the work period.
 - v. "Clean as you go" utilizing a HEPA filtered vacuum to remove tile debris.
 - vi. If more than one tile is lifted in these areas, contact EVS for regular cleaning.
- V. Reference Documents or Attachments
- a. Guidelines for Environmental Infection Control in Healthcare Facilities. CDC. (2019). <https://www.cdc.gov/infectioncontrol/pdf/guidelines/environmental-guidelines-P.pdf>.
 - b. Infection Control Risk Assessment Matrix of Precautions for Construction & Renovation. ASHE. (2009). https://www.ashe.org/sites/default/files/ashe/assessment_icra.pdf
 - c. Construction and Renovation. APIC. Chapter 118. (2019). <https://text.apic.org/toc/infection-prevention-for-support-services-and-the-care-environment/construction-and-renovation>

Figure 5 – Infection Control Contractor Check List

Start Up Sequence Check List for Precaution Class II, III, and IV Projects

- Locate and lay-down, storage, or cutting rooms, if available for the project.
- Movable equipment, furniture, and supplies have been removed from the work area.
 - This may include beds, chairs, tables, privacy curtains, and carts.
- If necessary, any fixtures are removed from the work area, put in storage *outside* of the work area if they are to be re-installed.
 - Examples include window treatments and light fixtures.
- Check that the barrier meets project requirements outlined in issued ICRMC.
 - Barriers shall be sealed *with tape* from top to bottom and side to side.
 - Drywall barriers have edges sealed to prevent breakdown and debris, should be painted and clean.
 - The project ICRMC and a manometer with negative air log, if necessary, are installed in an easy-to-see place on the exterior of the project barrier. Negative air logs must be logged by the contractor at least daily.
- If indicated, an ante room is available to clean boots, carts, people, and supplies leaving the work area.
- Tacky mats are located appropriately to prevent tracking.
- Ensure HVAC supplies and returns are securely covered; supplies and returns may not be uncovered until Infection Control approval.
 - Airflow may need to be reduced to keep returns and supplies securely covered.
 - New HVAC ductwork or equipment must be securely covered (duct wrap) until installation.
- Negative air machines shall have clean HEPA filters (and pre-filters, if used) on project start up. A filter log shall be kept and should be attached to each negative air machine.
- Negative air is always HEPA filtered and shall be discharged to a adjacent space or directly to the outdoors. Discharge into the HVAC system is not allowed.

General Site Maintenance Checklist for Precaution Class II, III, and IV Projects

- Barrier integrity and cleanliness must be maintained for the duration of the project.
- Supplies or returns that become uncovered must be secured immediately.
- Tacky mats must be pulled frequently enough so that there is always a tacky surface to step on.
- Inspect the area around the project site and the path from the project site to waste disposal at least once per day to look for tracking of dust and debris.
 - Contractor clothing and footwear, as well as equipment and carts should be vacuumed clean of all dust and debris before leaving the project site. Vacuuming to be done inside the project containment.
- Negative air must remain in place until completion of all dust generating activities and must remain in place for barrier cleaning and/or removal.

Figure 6 – Request for Outage

Engineering Services



Request For Outage

Today's Date: _____ Attention: _____

This Request for Outage (RFO) form should be utilized to request a planned outage. A planned outage is a system or service outage or disruption that has been planned and scheduled. Non-emergency outage requests should be made no later than 10 working days prior to the requested date to ensure all those affected by the outage have adequate time to notify occupants and put in place any required contingency plans.

Contractor <small>(Name, Phone & Email)</small>	
Project Name <small>(if applicable)</small>	
Project # / Work Order # <small>(if applicable)</small>	
Reason for Outage	

For any questions, please contact the University Health Care Engineering Services Office 573-882-3639

Please scan and email to UMHC Outage-Request email address: umhcoutage-request@health.missouri.edu

Outage Details

Type of Outage: <small>(system or systems affected)</small>				
Location of Outage: <small>(Building Name/Floor/Room)</small>				
Proposed Start Date & Time:	Date:		Time:	
Estimated End Date & Time:	Date:		Time:	

Outage Contacts (complete all applicable)

Outage Project Manager:			
Outage Proj.Mgr. Phone # & Email:			
Supervisor Contact Name:			
Supervisor Phone # & Email:			
1st Alternate Contact Name:			
1st Alternate Phone # & Email:			

**Figure 7 – Contractor-Vendor Acknowledgement of Electrical Safety Requirements
Training**

Contractor/Vendor:
Representative Name:
Representative Title:
Date:

The **University of Missouri Health Care’s (MUHC)** Electrical Safety Program is written to be consistent with OSHA and National Fire Protection Association 70E, Standard for Electrical Safety in the Workplace - 2021 Edition (NFPA 70E).

In accordance with NFPA 70E requirements, the MUHC requires that all contract employer representatives or any subcontractor under their authority, follow the work practices required by NFPA 70E and safety-related work rules required by the Host Employer, MUHC.

The following requirements must be agreed to before the performance of any tasks that may involve electrical hazards on MUHC managed properties:

The contract employer shall ensure that each of their employees or any subcontractor under their authority:	Do you agree? Y/N	Initials
are instructed in any hazards communicated to the contract employer by MU Health Care representatives.		
will notify an appropriate MU Health Care representative of any unique hazards presented by the contractor’s work.		
will notify the appropriate MU Health Care representative of any unanticipated hazards discovered during the course of their work.		
have received updated electrical safety training in accordance with NFPA 70E, 2021 Edition.		
will provide proof of updated electrical safety training for every employee before they perform any work that may involve electrical hazards on MU Health Care managed properties.		

Contractor / Vendor Representative:

Signature

MU Health Care Representative:

Name and Title

Signature

SECTION 01 0500
FIELD ENGINEERING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Project layout and field measurements.
- B. Existing 'shell' condition 3D laser survey.
- C. Existing floor flatness survey.
- D. Existing building system conditions.

1.02 RELATED SECTIONS

- A. Section 01 1000 - Summary.
- B. Section 01 3100 - Project Management and Coordination.
- C. Section 01 3150 - Coordination Drawings.
- D. Section 01 4000 - Quality Requirements.
- E. Section 01 5000 - Temporary Facilities and Controls.
- F. Section 01 7300 - Execution: Construction Manager requirements for coordination of OFCI and OFOI systems.
- G. Section 13 4942 - Radio Frequency Shielded Enclosure - Verification of Existing Conditions.
- H. Section 20 0100 - Basic Fire Protection, Plumbing, and HVAC Requirements.
- I. Section 23 0500 - HVAC Basic Materials and Methods.
- J. Section 26 0510 - Electrical Special Conditions.

1.03 QUALITY CONTROL

- A. The Sub-Contractors are to provide a quality control plan for the deliverable items to the Construction Manager.
- B. Construction Manager is to incorporate sub-contractor plans into overall Project Schedule.

1.04 QUALITY ASSURANCE

- A. The Construction Manager shall hire a qualified surveyor to provide 'laser survey' of existing conditions after demolition is complete for each project area. Document existing dimensions, building systems and overall layout. This documentation shall serve as the basis of data for the Coordination Documents.
- B. The Construction Manager is solely responsible for the layout of the Work including, but not limited to, all horizontal and vertical control and dimensional coordination as necessary to construct the Work in accordance with the Contract Documents.
- C. Based on Construction Manager room layout, each Trade Sub-Contractor shall lay out each portion of the Work in compliance with the prepared Coordination Drawings and in advance of its construction. The Construction Manager / General Contractor shall ensure dimensional coordination of the Work laid out with existing work and work to be subsequently constructed.
- D. The Construction Manager and Sub-Contractor shall carefully examine approved submittals prior to laying out parts of the Work. All through floor penetrations are to be coordinated prior to the start of the Work.
- E. Surveyor: Licensed in the State of Missouri and acceptable to the Owner and Design Team.

1.05 SUBMITTALS

- A. Qualification and certification of floor scan consultant.

- B. Name, address, telephone number and Missouri State registration license number of Surveyor prior to starting survey work.
- C. Survey data (note Contractor option to provide laser scan data).
- D. Submittal of 3D laser scan data.
- E. Submittal of 2D flatness and grid data.

1.06 EXAMINATION

- A. Verify locations of survey control points prior to starting Work.
- B. Verify existing tie-in elevations and horizontal references to all Building Systems including but not necessarily limited to:
 - 1. Structural envelope.
 - a. Floor plane.
 - b. Columns and shear walls.
 - c. Underside of rib slab.
 - 2. Existing walls, ceilings and fixed building elements.
 - 3. HVAC systems.
 - 4. Plumbing systems.
 - 5. Electrical systems.
 - 6. Low Voltage systems.
 - 7. Fire Protection systems.
- C. Promptly notify the Architect and Owner of any discrepancies discovered.

1.07 SURVEY REFERENCE POINTS

- A. Construction Manager to locate and protect all survey control and reference points.
- B. Control datum for survey is that established by the Construction Manager based on laser survey information provided by the Construction Manager.
- C. Protect survey control points (minimum of two) prior to starting new work and preserve permanent reference points during construction.

1.08 SURVEY REQUIREMENTS

- A. Provide field engineering services utilizing recognized engineering survey practices.
- B. Establish elevations, lines and levels. Locate and lay out by instrumentation and similar appropriate means:
- C. Provide background documentation for use by the Contractor to assist in coordination documentation and field layout.
- D. Provide up front validation of floor flatness to confirm remedial work if required earlier in the Project Schedule.
- E. Periodically verify layouts by same means.

1.09 3D LASER SURVEY REQUIREMENTS

- A. 3D Laser Scanning of Interior of Existing Buildings:
 - 1. Provide Interior 3D laser scans of the interior spaces of the existing East Pavilion to document the visible existing as-built conditions of the architectural, MEP, and structural elements.
 - a. Reasonable efforts should be made to scan areas from multiple positions and angles to ensure that proper coverage and accuracies are obtained.
 - b. Place semi-permanent markers in locations acceptable to owner to allow for future scanning of spaces as needed, and combine any new point cloud data with the original.

2. Provide colored imagery of the 3D laser scans to colorize the point cloud.
 3. Process, register, and analyze 3D laser scanning control and point cloud data to assure quality control.
 4. Prepare and provide a copy of a point cloud created by the scans and a copy of the 3D scan data in a cloud-based 3D viewing format.
- B. Conversion to 3D Models:
1. Convert 3D laser scans into 3D models as defined in the Execution section below.
- C. MEPFP Documentation:
1. Construction Manager responsible to coordinate scope of services herein with responsible Contractors to documents required survey information.
 - a. Section 20 0100 - Basic Fire Protection, Plumbing, and HVAC Requirements.
 - b. Section 23 0500 - HVAC Basic Materials and Methods.
 - c. Section 26 0510 - Electrical Special Conditions.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 DELIVERABLES

- A. 3D Laser Survey:
1. 3D Models:
 - a. Provide 3D model of major vertical elements including:
 - 1) Structural elements, shafts, piping, conduits, etc.
 - b. Provide 3D model of structural plan layout of floor overhead.
 - c. Convert the architectural, structural and MEP elements documented by the interior 3D laser scans into 3D model objects within Autodesk Revit 2019 .rvt models provided by the Contractor's coordination document team.
 - d. Elements are to be modeled using standard generic Revit families. Miscellaneous MEP equipment can be modeled as generic shapes if nothing exists that is close in the project specific or generic Revit families.
 - 1) Where there is uncertainty about how to model an element, the Contractor is to request clarification from the Design Team.
 2. 3D Point Clouds:
 - a. Raw laser scan data is to be provided as a 3D point cloud and in file formats suitable for use in the following software: Autodesk Revit 2021, Autodesk Navisworks, Autodesk ReCap360, Autodesk AutoCAD, Autodesk Civil3D, and 3D cloud-based viewing software.
 3. Imagery:
 - a. Provide panoramic data and true color imagery from the laser scanner's on-board camera to colorize the point cloud. If the laser scanner does not have an on-board camera, external imagery shall be provided and used to colorize the point cloud.
 4. Level of Accuracy:
 - a. Provide the Measured Accuracy Level for scan data and registration and Represented Accuracy Level as referenced from USIBD Document C220 Level of Accuracy (LOA) Specification. Revit elements should be modeled orthogonally. In case where orthogonal tolerances can't be met, those areas are to be highlighted and presented to the Design Team to determine how to proceed for the specific case.
 5. Units:
 - a. Architectural feet and inches.
 6. Level of Development (LOD):
 - a. Provide a level of development LOD 200 per BIM Execution Plan.
 7. Transmittal of Deliverable:

- a. Deliverable data is to be transmitted to the Design Team and RF Shielding Vendor as progress is made through the following way:
 - 1) Portable external hard drives delivered to the Design Team.
 - b. The Owner is to have ownership of all deliverable data.
 - c. The Subconsultant is to store a copy of all data for the duration of the project.
- B. Floor Flatness:
1. Provide grid in AutoCAD format overlaid on background plan with all building references, column lines, exterior wall and internal building elements represented.
 2. Provide paper copy 1/8" = 1'-0".
 3. Level of accuracy equal to plus / minus 1/8".
 4. Units:
 - a. Architectural fractions of an inch.
- C. MEPFP Documentation:
1. Provide existing conditons survey documentation to the respective Contractors for use in developing Coordination Documentation.

END OF SECTION 01 0500

**SECTION 01 3150
COORDINATION DRAWINGS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. The Section includes coordination drawings for areas containing more than one (1) of the following:
 - 1. Building structural elements
 - 2. Building miscellaneous metal support systems.
 - 3. Partition bracing.
 - 4. Storm Lines.
 - 5. Ductwork.
 - 6. Plumbing.
 - 7. Medical gas piping.
 - 8. Piping.
 - 9. Recessed light fixtures.
 - 10. Electrical conduit 1-1/2" diameter and larger.
 - 11. Electrical conduit bundles of any size in excess of three conduits.
 - 12. Electrical cable tray or duct systems.
 - 13. Ceilings
 - 14. RF Shielding System.
 - 15. Other areas indicated by the Architect that involves congestion of utilities and building components.

1.02 QUALITY ASSURANCE

- A. Prepare coordination drawings by personnel familiar with requirements of this project and skilled, as a competent technician as a CAD or Revit operator to prepare required drawings.
- B. The Construction Manager is responsible for the coordination of the work and is to provide overall guidance and direction to the personnel preparing Coordination Documentation.

1.03 PROJECT REQUIREMENTS

- A. It is the intent for the work of this project to be coordinated prior to the start of the work in the field. The General Contractor / CM is the responsible party to the Owner for this coordination effort.
- B. Reference 01 0500 – Field Engineering for detail information regarding survey and inclusions of existing conditions on the Coordination Documents.
- C. Complete the coordination drawing process prior to submitting submittals for items included in the coordination drawings.
 - 1. The mechanical, piping, and ceiling layout drawings may be used as the basis for shop drawings when combined with proper level of documentation indicated, providing they are in compliance with their particular section.
- D. The Coordination Drawings are considered Informational Submittals as stipulated in Section 01 3300 - Submittal Procedures, but are required prior to the start of the work.
- E. Contractors are required to execute use of Electronic Media Release Form.

1.04 ORDER OF PRECEDENCE OF EQUIPMENT AND ITEMS

- A. The list below is the precedence of assigned work items for space priority in descending order. Items not listed shall have the same precedence as similar items.
 - 1. Reflected ceiling with light fixtures, access above light fixtures required for maintenance, sprinkler head locations, ceiling fixtures and devices, and fixed equipment support framing.

2. Space designed for future utility placement and fixed equipment support framing.
3. RF Shielding System components.
4. Gravity flow plumbing waste, roof drainage, steam condensate return, gravity flow central wet vacuum, and other systems that rely upon gravity for flow.
5. Miscellaneous metal support devices for building components.
6. Ductwork and appurtenances, except that external bracing shall be relocated to accommodate local interference.
7. Cable tray with access identification 18" horizontal to 6" above tray.
8. Electrical conduit over one and a half (1-1/2) inches in diameter and bundles of 3 or more of any size.
9. HVAC piping except for gravity flow steam condensate and pressurized domestic water piping.
10. Fire line mains and sprinkler piping.
11. Plumbing vents.

1.05 PARTICIPATION

- A. The General Contractor, Subcontractors and Owners Proprietary Contractors are responsible for items of work located in or above ceilings and shall participate in the Coordination Drawing process. Participation is mandatory. If the General Contractor or subcontractor fails to participate in the coordination drawing process, the Owner reserves the right to undertake the following:
1. Stop construction progress payments for work performed by the General Contractor, subcontractors, or vendors. Payments will be re-instated only after the General Contractor or subcontractor resumes participation in the coordination drawing process.
 2. Require the relocation and resizing of components as necessary to ensure components will be installed as intended. In the event the General Contractor did not participate in the coordination process, the General Contractor will not be entitled to contract cost increases or time extensions due to Owner initiated changes in the work.
 3. The General Contractor shall be held responsible for unnecessary rework that is attributable to failure to participate in the coordination process.

1.06 COORDINATION DOCUMENT REQUIREMENTS

- A. Preparation: Prepare coordination drawings using CAD, Revit or Navisworks system acceptable to all parties involved in the coordination drawing process. Supplement with manual drawings as needed.
1. CAD, Revit or Navisworks Program: AutoCAD 2019/Revit 2021 or more recent version.
 2. Scale of drawings:
 - a. General plans: 1/4" = 1'-0" (minimum) or as otherwise agreed.
 - b. Mechanical, electrical, communication rooms (including the surrounding 10'-0" area): 1/2" = 1'-0" (minimum).
 - c. Shafts and risers: 1/2" = 1'-0" (minimum).
 - d. Sections of shafts and mechanical and electrical equipment rooms: 3/8" = 1'-0" (minimum).
 - e. Sections of congested areas: 3/4" = 1'-0" (minimum).
 3. Prepare the coordination CAD, Revit or Navisworks files in accordance with the AutoDesk layering system. Each major trade/system shall be delineated on a separate drawing layer.
- B. The minimum quantity of drawings will be established at the first coordination meeting and will include all building levels and areas at 1/4" as a minimum. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.01 GENERAL

- A. Provide coordination in determining adequate clearance and space requirements for mechanical, electrical and other items/equipment in the project.
 - 1. The Owner and the Architect reserve the right to determine space priority of equipment in the event of interference between pieces of equipment, piping, conduit, ducts and equipment of the trades.
 - 2. The Owner and the Architect will only review conflicts identified by the Contractor and give an opinion, but will not perform as a coordinator.
- B. Provide coordination drawings indicating structural components, reflected ceiling layout, mechanical items and electrical items.
- C. Indicate on the coordination drawings:
 - 1. Where components will be installed and how the service access area to such items shall be maintained. Illustrate items requiring access for maintenance of adjustment.
 - 2. Deviations from the intent of the Contract Documents that are necessary for overall systems installations and coordination using a clouding of areas of deviations with sufficient notation to identify the elements to be modified.
- D. The Contract Documents as prepared by the Architect and Engineer are schematic in nature and do not show every fitting and appurtenance for each utility.
 - 1. Each contractor is expected to have included in his bid sufficient fittings, material and labor to allow for adjustments in routing of utilities made necessary by the coordination process.
 - 2. The Contractor will not be allowed any contract cost extra or time extension for changes dictated by the coordination process.
- E. Access to mechanical and electrical items shall be through accessible acoustical ceiling areas. Additional access panels will not be allowed without written approval from the Architect at the coordination drawing stage and only after alternatives are reviewed. Layout changes shall be made to avoid additional access panels. If additional access panels are required, they shall be provided at no additional cost to the Owner.
- F. Soffit penetrations and light alcoves shall be fully coordinated with hanging devices, studs, fire/smoke ratings and structural support requirements.

3.02 PROCEDURE

- A. Initial Coordination:
 - 1. Prior to start of construction, a meeting shall be scheduled by the Contractor with participants responsible for the coordination of the work. Coordination drawing requirements shall be implemented in relation to the project progress schedule, which shall be drafted or modeled with qualified personnel to produce high quality drawings or documentation/Construction Manager.
 - 2. The Contractor/Construction Manager shall incorporate the existing conditions into the Contractor's base reference coordination documentation and this shall serve as the basis of the existing conditions for the Coordination Drawing process.
 - a. Existing conditions verification shall include verification and documentation of existing conditions. Reference requirements for laser scan under Section 01 0500 Field Engineering.
 - b. Contract/Construction Manager is responsible to coordinate with RF Shield Vendor. Contractor/Construction Manager to furnish laser data to RF Vendor for preparation of RF Shield Documents.

- c. RF Shield Documents in conjunction with laser survey to serve as the basis of Coordination Documentation.
 - d. Contractors are required to adjust the documentation (model) as provided under 3.02B to incorporate the detail laser survey data into the Coordination Drawings.
 3. The Contractor/Construction Manager shall provide to coordination participants composite base sheet documentation files as provided by the Owner free of charge indicating the following. Reference 1.03, E. Execution of Media Release Form for access to Drawing Files:
 - a. Column center lines with structural beams and sizes as required to coordinate the work.
 - b. Exterior walls.
 - c. RF Shielding Documentation.
 - d. Interior partition locations with dimensions required and wall types verified. Fire and smoke ratings of partitions.
 - e. Reflected ceilings with ceiling components located.
 - f. The base files shall reference the applicable architectural, structural, mechanical, electrical, fire protection, plumbing, and reflected ceiling drawings.
 4. The ductwork documents shall be roughed out as a point of beginning for use as a base for other components. The ductwork documents shall be modified to accommodate other components as the coordination drawings progress. The ductwork documents shall indicate the following:
 - a. Duct sizes including insulation, fire/smoke dampers outside dimension.
 - b. Equipment layouts and service clearances.
 - c. Dimensions from column lines.
 - d. Dimensions from finished floors to bottom of ducts.
 - e. Dimensions from structural openings (wall/floor) showing that finished items will fit.
 - 1) Sectional views shall be provided in congested areas.
 - 2) Unless otherwise required, ductwork shall be maintained in existing position. Any new ductwork to be coordinated tight to the underside of floor slabs and/or beams (no damage to the fireproofing will be allowed).
 - 3) Fit ductwork into structural 'pan' where indicated. Coordinate with Architect for any structural modifications not specifically indicated on the Contract Documents.
 - 4) Ductwork layouts shall be produced in sequence in conjunction with the project schedule. The earliest area indicated in the schedule will dictate the first effort.
 5. The location of HVAC equipment and other equipment above the ceiling shall be indicated along with future utility routings indicated on the Contract Drawings on their own layers as identified by the Architect.
 6. When the base sheet/ductwork documents for the earliest scheduled area have been completed (time limitation as determined as the initial coordination meeting) the base documentation shall be distributed to the coordination participants for use in indicating the major components of proposed installation using the Contract Documents as a guide.
- B. Coordination Meetings:
 1. Contractor shall schedule and conduct coordination meetings on a routine and frequent basis, to coordinate with the subcontractors, Architect and Owner's Other Consultants availability, in order to expedite the coordination document process.
 2. Within a period of not to exceed two (2) weeks after distribution of the base drawings, a meeting shall be scheduled with the coordination participants to resolve areas of conflict.
 - a. Meeting participants shall analyze documentation to identify areas of conflict, cooperate in resolving the conflicts.

- b. The coordination document participants shall recommend changes, rerouting, resizing or relocation of components, if necessary, so all trades can install their systems in the space allotted.
 - c. Any proposed changes from the systems layout on the construction documents, shall be done in accordance with the design criteria specified in applicable codes and standards and BJCHC criteria outlined in each technical section.
 - d. Changes shall be subject to the review and acceptance of the Owner and the Architect.
 - e. Distribute two (2) blackline composites copies or appropriate documentation indicating resolutions to coordination participants.
 - f. The coordination process shall be repeated until all areas of the Work have been coordinated.
 3. Coordination participants shall provide equipment installation and clearance requirements. This information shall be indicated on the coordination documents.
 4. Coordination documents shall indicate the following major system components (including insulation, hub or connection widths with verification of turning radius):
 - a. Large storm piping.
 - b. Large waste piping.
 - c. Plumbing cleanouts.
 - d. Sprinkler mains.
 - e. Clearance to RF Shielding.
 - f. Equipment located above the ceiling.
 - g. Heating hot water piping.
 - h. Chilled water piping.
 - i. Conduit runs, 1-1/2" and larger and all conduit bundles in excess of three (3) conduits of any size.
 - j. Unistrut support system.
 - k. Recessed light fixtures.
 - l. Building wiring or cable trays.
 - m. Ceiling heights.
 - n. Soffits (including framing of supports).
 - o. Access points and clearances required.
 - p. Access panels.
 - q. Valves, dampers and coils.
 - r. Ductwork.
 - s. Fire rated wall, partition, and floor penetrations.
 - t. Space allotted for future utilities.
 - u. Equipment in mechanical and electrical spaces.
 - v. Supports and bracing.
 5. Information shall be delineated to indicated distances from column centerlines, pipe/equipment size and distance from finished floor to bottom of pipe/equipment and hangers.
- C. Provide composite documentation review sets, with one (1) set at each review period to each trade involved.
 1. Post document files to CD/DVD and submit with hard copy drawings.
- D. The coordination drawings shall be submitted to the Architect/Engineer for information, as requested by the Architect/Engineer. The submitted coordination drawings shall indicate which contractors participated in the process and where conflicts appear to occur even after the priority ranking of utility routing has been utilized. In the event that conflicts require input from the Architect/Engineer, the Contractor shall provide recommended solutions with the coordination drawings. The Architect/Engineer will review the Contractor's recommended

solutions and return with their opinion to the Contractor's for consideration. The Contractor, subcontractors and Owner's vendors shall agree to the final coordinated layout by signing off on the coordination drawings in a signature block as developed by the Contractor before any construction can begin.

- E. Maintain an updated set of coordination drawings at the job site reflecting changes, modifications and adjustments. Changes shall be reflected and sets or new sheets reissued to the Architect and the Owner for information on a monthly basis with changes "clouded" and brought to the attention of the Architect/Engineer and the Owner.
- F. When a Contract Modification (supplemental instruction, proposal request or construction change directive) is issued, the Contractor shall review the coordination drawings and shall update all coordination drawings as required to document the work.
- G. Coordination participants that fail to cooperate in the coordination drawing effort shall be responsible for all costs incurred for adjustments to the work made necessary to accommodate installations. Provide adequate clearance and access through accessible ceilings. Conflicts that result after the coordination drawings are signed-off will be the responsibility of the Contractor.
- H. At substantial completion, and electronic copy of the document files on CD/DVD, one (1) set of prints and one (1) reproducible mylar copy of the coordination drawings shall be submitted to the Owner for review and acceptance.

END OF SECTION 01 3150

SECTION 02 4116
DEMOLITION FOR REMODELING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Work included in this Section: Demolition and removal of existing construction as designated or required to provide for New Work. Refer to demolition drawings and notes. Work includes, but is not limited to the following:
 - 1. Demolition of exterior envelop and precast stone panels to incorporate quench vent assembly.
 - 2. Interior partitions where noted from underside of structure above down to top of subfloor including associated doors and frames.
 - 3. Removal of all interior construction including floor finishes and ceiling construction.
 - 4. Demolition / removal of existing concrete slab construction to incorporate magnetic shielding system in floor.
 - 5. Removal and reinstallation of Plumbing, Fire Protection, HVAC, and Electrical systems.
 - 6. Coordination of demolition of mechanical, plumbing, fire protection and electrical items.
- B. Related work not included in this Section:
 - 1. Temporary shoring and bracing, cranes, hoists, chutes required for work of this section.

1.02 RELATED SECTIONS

- A. Section 01 1000 - Summary: Description of items to be salvaged or removed for reuse by Contractor / turn over to Owner.
- B. Section 01 1045 - Cutting and Patching.
- C. Section 01 5000 - Construction Facilities and Temporary Controls: Temporary shoring and bracing, cranes, hoists, chutes required for work in this section.
- D. Section 01 5721 - Indoor Air Quality Controls.
- E. Section 01 6000 - Product Requirements: Handling and storage of items removed for salvage and relocation.
- F. Section 01 7200 - Record Documents: Project record documents.
- G. Section 01 7700 - Project Closeout.
- H. Section 01900 - Miscellaneous Requirements: Demolition work to be conducted under premium time.

1.03 INCORPORATED DOCUMENTS

- A. Published specifications, standards, tests, or recommended methods of trade, industry, or governmental organizations apply to work of the Section where cited by abbreviations noted below.
 - 1. American National Standards Institute's "American National Standard Safety Requirements for Demolition" (ANSI A10.6).

1.04 SUBMITTALS

- A. See Special Conditions - Submittals, for submittal procedures.
- B. Program of methods and time schedule for accomplishing this Work.
- C. Report of inspections conducted with the Owner both before and after performing work. See Field Quality Control article. (Section 01 4000).
- D. Project Record Documents: Accurately record actual locations of capped utilities and any relocated services.

1.05 QUALITY ASSURANCE

- A. Requirements of Regulatory Agencies:
 - 1. Comply with all applicable provisions of safety laws and building codes pertaining to demolition.
 - 2. State and local code requirements shall control disposal of debris.

1.06 REGULATORY REQUIREMENTS

- A. Obtain required permits from authorities.
- B. Do not close or obstruct egress from any building exit or site exit.
- C. Do not disable or disrupt building fire or life safety systems without 7 days' prior written notice to Owner.
- D. Conform to applicable regulatory procedures when hazardous or contaminated materials are discovered.

1.07 SEQUENCING

- A. Sequence work under the provisions of Section 01 1000: Summary.

1.08 SCHEDULING

- A. Coordinate with the Owner in scheduling noisy, dirty, or wet work.
- B. Schedule work at the Owner's convenience to cause minimal interference with the Owner's normal operations.
- C. Obtain the Owner's approval of times scheduled for coring, jackhammering, and other demolition means which may cause excessive vibration or noise.
- D. Schedule work to coincide with new construction.

1.09 PROJECT CONDITIONS

- A. Conduct demolition to minimize interference with adjacent and occupied building areas.
- B. Cease operations immediately if structure appears to be in danger and notify Architect. Do not resume operations until directed.
- C. Disposition of Existing Improvements:
 - 1. Materials forming portions of permanent structure designated for demolition shall become the Contractor's property, and the Contractor shall be responsible for their removal unless otherwise noted.
 - 2. Personal property and movable furniture remain the Owner's property to be removed by the Owner. Consider items not claimed by the Owner as debris.
 - 3. Disconnect, carefully remove, and store at the Owner-designated locations within the contract Boundary all equipment items which the Owner will dispose of either off or on site in manner not to interfere with the Contractor's operation.
 - 4. The use of small mobile equipment will not be permitted.
- D. Protection:
 - 1. Erect and maintain temporary bracing, shoring, lights, barricades, except construction barricades for subsequent new construction, warning signs, and guards necessary to protect public, the Owner's employees, finishes, and improvements to remain and adjoining property from damage, all in accordance with applicable regulations.
 - 2. Prevent the spread of dust and dirt. All temporary dust partitions shall meet the requirements as established in Construction Facilities and Temporary Controls, Section 01 5000.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 INSPECTION

- A. Examine areas affected by work of this Section and verify following:
 - 1. Disconnection of utilities as required.
 - 2. That utilities serving occupied portions of buildings will not be disturbed.
 - 3. Removal by the Owner of the Owner's personal property, movable furniture, and equipment items not designated for relocation.
- B. Where existing conditions conflict with representations of the Contract Documents, notify the Architect and obtain clarification.
- C. Do not start work until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Provide, erect, and maintain temporary barriers at locations indicated.
- B. Erect and maintain weatherproof closures for exterior openings.
- C. Erect and maintain temporary partitions to prevent spread of dust, odors, and noise to permit continued building occupancy.
- D. Protect existing materials and construction that are not to be demolished.
- E. Notify affected utility companies before starting work and comply with their requirements.
- F. Mark location and termination of utilities.
- G. Provide appropriate temporary signage including signage for exit or building egress.
- H. Lay out work to be demolished at job site and coordinate with related work for which cutting is required.
- I. Review proposed layout with the Architect prior to performing demolition.

3.03 DEMOLITION

- A. Demolish in an orderly and careful manner. Protect existing supporting structural members .
- B. Perform work in accordance with ANSI A10.6 unless otherwise noted.
- C. Lower heavy structural framing members by hoist or crane.
- D. Concrete and Masonry:
 - 1. Do not jackhammer within two inches of reinforcing or structural steel; remove final two inches of material with chipping gun.
 - 2. Demolish concrete and masonry in small sections, less than three feet in any direction.
 - 3. Do not allow masonry walls to fall to floor.
 - 4. Sawcut perimeter of all areas where slabs are noted to be removed.

3.04 REMOVALS

- A. Remove from job site salvage and debris as they accumulate. Do not permit presence of debris to delay progress of related work.
- B. Nothing to be removed from site shall be stored, sold, or burned on site.
- C. Remove all materials not to be reused on site; comply with requirements of Section 01 7419 - Construction Waste Management and Disposal.

3.05 FIELD QUALITY CONTROL

- A. The Contractor shall:

1. Before performance of work, make inspection and report defects and structural weaknesses of structures to be partially demolished, cut, or removed, of adjacent structures, and of improvements remaining.
 2. After performance of work, make inspection and report defects and structural weaknesses of structures partially demolished, cut, or removed, of adjacent structures, and of improvements remaining.
- B. The Owner will accompany the Contractor before and after performance of work to confirm physical condition of structures or improvements involved.

END OF SECTION 02 4116

SECTION 03 5400
CAST UNDERLAYMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

1.02 RELATED REQUIREMENTS

- A. Section 01 2200 - Unit Prices.
- B. Section 09 6500 - Resilient Flooring.

1.03 REFERENCE STANDARDS

- A. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50 mm] Cube Specimens); 2021.
- B. ASTM C1602/C1602M - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete; 2018.
- C. ASTM C348 - Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars; 2021.
- D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.

1.04 SUBMITTALS

- A. See Special Conditions - Submittals, for submittals procedures.
- B. Product Data: Provide manufacturer's data sheets documenting physical characteristics and product limitations of underlayment materials. Include information on surface preparation, mixing instructions, environmental limitations, storage and handling requirements, and installation instructions.
- C. Certificate: Certify that products meet or exceed specified requirements.

1.05 QUALITY ASSURANCE

- A. Applicator Qualifications: Company specializing in performing the work of this section, and approved by manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Keep dry and protect from direct sun exposure, freezing, and ambient temperature greater than 105 degrees F (41 degrees C).

1.07 REGULATORY REQUIREMENTS

- A. Conform to applicable code for combustibility or flame spread requirements.
- B. Provide certificate of compliance from authority having jurisdiction indicating approval of underlayment materials in the required fire rated assembly.

1.08 FIELD CONDITIONS

- A. Do not install underlayment until floor penetrations and peripheral work are complete.
- B. Maintain minimum ambient temperatures of 50 degrees F (10 degrees C) 24 hours before, during and 72 hours after installation of underlayment.
- C. During the curing process, ventilate spaces to remove excess moisture.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Cementitious Underlayment:

1. ARDEX Engineered Cements; ARDEX V 1200 with ARDEX P51 Primer:
www.ardexamericas.com/#sle.
2. Mapei; Product "Novoplan 2 Plus": www.mapei.com.
3. Sika Corporation; Product "Sika Level-225": www.usa.sika.com.
4. Master Builders Technology (BASF); Product "MasterTop 110 SL Underlayment":
www.master-builders-solutions.basf.us.
5. Substitutions: See Section 01 2500 - Substitutions.

2.02 MATERIALS

- A. Cementitious Underlayment: Blended cement mix, that when mixed with water in accordance with manufacturer's directions will produce self-leveling underlayment with the following properties:
 1. Compressive Strength: Minimum 5,300 pounds per square inch (371 kg/sq. cm.) after 28 days, tested per ASTM C109/C109M.
 2. Flexural Strength: Minimum 1000 psi (6.9 MPa) after 28 days, tested per ASTM C348.
 3. Density: 125 pounds per cubic foot (2002 kg/cu m), nominal.
 4. Final Set Time: 1-1/2 to 2 hours, maximum.
 5. Thickness: Capable of thicknesses from feather edge to maximum 3-1/2 inch (89 mm).
 6. Surface Burning Characteristics: Flame spread/Smoke developed index of 0/0 in accordance with 1.
- B. Aggregate: Dry, well graded, washed silica aggregate, approximately 1/8 inch (3 mm) in size and acceptable to underlayment manufacturer.
- C. Reinforcement: Galvanized metal lath complying with recommendations of underlayment manufacturer for specific project circumstances.
- D. Water: ASTM C1602/C1602M; clean, potable, and not detrimental to underlayment mix materials.
- E. Primer: Manufacturer's recommended type.
- F.

2.03 MIXING

- A. Site mix materials in accordance with manufacturer's instructions.
- B. Add aggregate for areas where thickness will exceed 1/2 inch (12.7 mm). Mix underlayment and water for at least two minutes before adding aggregate, and continue mixing to assure that aggregate has been thoroughly coated.
- C. Mix to self-leveling consistency without over-watering.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate surfaces are clean, dry, unfrozen, do not contain petroleum byproducts, or other compounds detrimental to underlayment material bond to substrate.

3.02 PREPARATION

- A. Concrete: Mechanically prepare steel troweled concrete to create a textured surface necessary to achieve the best bond; acceptable methods include bead blasting and scarifying. Do not use acid etching.
- B. Remove substrate surface irregularities. Fill voids and deck joints with filler. Finish smooth.
- C. Vacuum clean surfaces.
- D. Prime substrate in accordance with manufacturer's instructions. Allow to dry.
- E. Close floor openings.

3.03 APPLICATION

- A. Place to required thickness, with top surface level to 1/16 inch in 10 ft (1:2000).
- B. Place before partition installation.
- C. Where additional aggregate has been used in the mix, add a top layer of neat mix (without aggregate), if needed to level and smooth the surface.
- D. If a fine, feathered edge is desired, steel trowel the edge after initial set, but before it is completely hard.

3.04 CURING

- A. Once underlayment starts to set, prohibit foot traffic until final set has been reached.
- B. Air cure in accordance with manufacturer's instructions.

3.05 PROTECTION

- A. Protect against direct sunlight, heat, and wind; prevent rapid drying to avoid shrinkage and cracking.
- B. Do not permit traffic over unprotected floor underlayment surfaces.

END OF SECTION 03 5400

SECTION 05 4000
COLD-FORMED METAL FRAMING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Formed steel stud interior wall framing at wall mounted MRI magnetic shielding.
- B. Exterior steel stud framing modifications to accomodate new mechanical ductwork/louwer.

1.02 RELATED REQUIREMENTS

- A. Section 061000 - Rough Carpentry: Rough wood blocking / plywood sheathing.
- B. Section 07 2100 - Thermal Insulation: Insulation within framing members.
- C. Section 09 2116 - Gypsum Board Assemblies: Gypsum-based sheathing.
- D. Section 09 2216 - Non-Structural Metal Framing.
- E. Section 13 4906 - MRI - Magnetic Shielding: Magnetic shielding supported by steel stud partition framing.

1.03 REFERENCE STANDARDS

- A. AISI S100 - North American Specification for the Design of Cold-Formed Steel Structural Members; 2016, with Supplement (2020).
- B.
- C.
- D. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- E. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.
- F.
- G.
- H. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2011.
- I. ASTM A1008/A1008M - 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; 2013.
- J. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2014.
- K. ASTM A780/A780M - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings; 2020.
- L. ASTM C955 - Standard Specification for Cold-Formed Steel Structural Framing Members; 2018, with Editorial Revision.
- M. ASTM C1007 - Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories; 2020.
- N. AWS D1.1/D1.1M - Structural Welding Code - Steel; American Welding Society; 2010.
- O. AWS D1.3 - Structural Welding Code - Sheet Steel; American Welding Society; 2008.
- P.

- Q. MFMA (GU) - Guidelines for the Use of Metal Framing; Metal Framing Manufacturers Association; current edition.
- R. NAAMM ML/SFA 540 - Lightweight Steel Framing Systems Manual; The National Association of Architectural Metal Manufacturers; 1987, Third Edition.

1.04 SUBMITTALS

- A. See Special Conditions - Submittals, for submittal procedures.
- B. Product Data: Provide data on standard framing members; describe materials and finish, product criteria, limitations.
- C. Shop Drawings: Indicate component details, framed openings, bearing, anchorage, loading, welds, and type and location of fasteners, and accessories or items required of related work.
 - 1. Indicate stud layout.
 - 2. Describe method for securing studs to tracks and for bolted and welded framing connections.
- D. Stud design calculations, including all connections.
- E. Manufacturer's Installation Instructions: Indicate special procedures, conditions requiring special attention.

1.05 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Selection 01 4000 "Quality Requirements," to design cold-formed steel framing.
 - 1. Prior to submitting Shop Drawings and Delegated-Design Submittal to the Architect and Engineer to review, complete the following:
 - a. Coordinate attachment points, method of attachment, and minimum gauge framing for Cold Form Metal Framing and/or other systems framing into Cold Formed Metal Framing.
 - b. Loads shall be indicated on the approved shop drawings for each system framing into Cold Formed Metal Framing.
- B. Calculations: Calculations showing the design of all cold-formed metal framing designs and connections to structure shall be provided to Architect/Engineer for review/approval to ensure compliance with project requirements. Calculations are to be signed and sealed by a registered Missouri Professional Engineer.
- C. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated. Contractor shall hire an Engineer licensed in Missouri to design the lite gage framing, including all connections, clips, anchors, embed steel connections, and miscellaneous attachments necessary to construct the light gage framing. Use member depths as indicated on drawings. Member gauges shown are minimums. Member flange widths shown on drawings are minimums. Member spacings shown on drawings are maximums.
 - 1. Design Loads:
 - a. Minimum lateral pressure: 5 psf.
 - b. Design for casework, shielding or any other wall hung equipment items. Coordination required loads with equipment manufacturers.
 - c. Design for lateral seismic loading for Non-Structural Components, ASCE Chp 13.
 - 2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
 - a. Interior Non-Load-Bearing Framing: Horizontal deflection of 1/360 of the wall height under a horizontal load.

2.01

- A.
 - 1. Marino/Ware.
 - 2. Clark/Dietrich Industries.
 - 3. SuperStud Building Products, Inc.
 - 4. Substitutions: See Section 01 2500 - Substitutions.
- B.
 - 1. Same manufacturer as metal framing.
 - 2. Substitutions: See Section 01 2500 - Substitutions.

2.02

- A. Provide primary and secondary framing members, bridging, bracing, plates, gussets, clips, fittings, reinforcement, and fastenings as required to provide a complete framing system.
- B.

2.03

- A.

2.04 METAL FRAMING

- A. System Components: Provide manufacturer's standard 16 gauge by 1-3/8 inch load-bearing steel studs of size as indicated unless otherwise noted. With each type of metal framing required, provide manufacturer's standard steel runners (tracks), blocking, lintels, clip angles, shoes, deflection channels, reinforcements, fasteners, and accessories for applications indicated, as needed to provide a complete metal framing system. Same as UniMast, Inc.'s "SJ Studs"; or approved equal.
- B. Materials and Finishes:
 - 1. Fabricate metal framing components of structural quality steel sheet with a minimum yield point of 33,000 psi (18 ga and 20 ga), 50,000 psi (16 ga, 14 ga and 12 ga); 1, or 2.
 - 2. Provide galvanized finish to metal framing components complying with ASTM A653/A653M for minimum G60 coating.
 - 3. Finish of installation accessories to match that of main framing components, unless otherwise indicated.
 - 4. Fasteners: Provide nuts, bolts, washers, screws, and other fasteners with corrosion-resistant plated finish.
 - 5. Electrodes for Welding: Comply with AWS Code and as recommended by stud manufacturer.
 - 6. Galvanizing Repair: Where galvanized surfaces are damaged, prepare surfaces and repair in accordance with procedures specified in ASTM A780/A780M.

2.05 FABRICATION

- A. Fastenings: Attach components by welding or bolting as standard with manufacturer. Comply with Contract Documents where welds are indicated.
- B. Wire tying of framing components is not permitted.
- C. Fabrication Tolerances: Fabricate units to a maximum allowable tolerance variation from plumb, level, and true to line of 1/8 inch in 10 feet.

2.06 ACCESSORIES

- A. Bracing, Furring, Bridging: Formed sheet steel, thickness determined for conditions encountered; finish to match framing components.

- B. Plates, Gussets, Clips: Formed Sheet Steel, thickness determined for conditions encountered; finish to match framing components.
- C.
- D. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.

2.07 FASTENERS

- A. Self-Drilling, Self-Tapping Screws, Bolts, Nuts and Washers: Hot dip galvanized per 1.
- B. Anchorage Devices: Powder actuated.
- C. Welding: In conformance with 1.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate surfaces and building framing components are ready to receive work.
- B. Coordinate layout of stud framing at perimeter of MRI Exam Room (parent wall) with layout of magnetic shielding panel layouts. Coordinate location of horizontal framing/backing.

3.02

- A.

3.03 INSTALLATION OF STUDS

- A.
- B. Align floor and ceiling tracks; locate to wall layout. Secure in place with fasteners at maximum 24 inches (600 mm) oc. Coordinate installation of sealant with floor and ceiling tracks.
- C. Place studs at maximum 16 inches (400 mm) on center; not more than 2 inches (50 mm) from abutting walls and at each side of openings. Connect studs to tracks using fastener method at both inside and outside flanges.
- D. Construct corners using minimum of three studs. Install double studs at wall openings, door and window jambs.
- E. Install studs full length in one piece. Splicing of studs is not permitted.
- F. Install studs, brace, and reinforce to develop full strength and achieve design requirements.
- G. Coordinate placement of insulation in multiple stud spaces made inaccessible after erection.
- H. Install intermediate studs above and below openings to align with wall stud spacing.
- I.
- J. Attach cross studs to studs for attachment of fixtures anchored to walls.
- K. Install framing between studs for attachment of mechanical and electrical items, and to prevent stud rotation.
- L.
- M. Install horizontal stiffeners in stud system, spaced (vertical distance) at not more than 54 inches on center. Weld at each intersection.

3.04 TOLERANCES

- A. Maximum Variation from True Position: 1/8 inch.
- B. Maximum Variation of any Member from Plane: 1/8 inch.

END OF SECTION 05 4000

SECTION 05 5000
METAL FABRICATIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fabricated metal items, related accessories, and fasteners including but not necessarily limited to the following:
 - 1. Countertop supports.
 - 2. Hoisting eye-bolts, ceiling bolts, and eye-bolts.
 - 3. Overhead supports for items noted including, but not necessarily limited to, the following:
 - a. Ceiling mounted equipment, including Owner furnished medical equipment.
 - b. Sliding glass door units.
 - 4. Equipment mounting studs, plates, tubes, channels, angles, etc.
 - 5. Miscellaneous support for emergency exhaust ductwork and quench vent assemblies.
- B. Standard catalog products, related accessories, and fasteners including but not necessarily limited to the following:
 - 1. Architectural channel framing system.
 - 2. Aluminum architectural channel framing system for support of MRI Exam Room ceiling.

1.02 RELATED REQUIREMENTS

- A. Section 06 1000 - Rough Carpentry: Fire treated wood backing.
- B. Section 09 2216: Non-Structural Metal Framing: Backing plates unless otherwise noted.
- C. Section 09 9000 - Painting and Coating: Paint finish.
- D. Section 13 4942 - Modular RF/EM Shielded Rooms: RF Room ceiling support members.

1.03 REFERENCE STANDARDS

- A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- B. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2022.
- C. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2018.
- D. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength; 2021.
- E. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength; 2014.
- F. ASTM A325M - Standard Specification for Structural Bolts, Steel, Heat Treated 830 MPa Minimum Tensile Strength (Metric); 2014.
- G. ASTM B211/B211M - Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire; 2019.
- H. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- I. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.
- J. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric); 2014.
- K. ASTM B210 - Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes; 2012.

- L. ASTM B211M - Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold-Finished Bar, Rod, and Wire (Metric); 2012.
- M. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- N. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.
- O. 11
- P. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; 2020.
- Q. AWS D1.1/D1.1M - Structural Welding Code - Steel; American Welding Society; 2010.
- R. SSPC-Paint 15 - Steel Joist Shop Primer/Metal Building Primer; 2004.
- S. SSPC-Paint 20 - Zinc-Rich Coating (Type I - Inorganic, and Type II - Organic); 2019.
- T. SSPC-SP 2 - Hand Tool Cleaning; 2018.

1.04 SUBMITTALS

- A. See Special Conditions - Submittals, for submittal procedures.
- B. Product Data: Indicate components of architectural channel framing system and all associated fasteners and accessories.
- C. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.
 - 1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
- D. Welders' Certificates: Submit certification for welders employed on the project, verifying AWS qualification within the previous 12 months.
- E. Samples: Only as required.

1.05 QUALITY ASSURANCE

- A. Design of any connections required for the execution and installation of the work are to be under direct supervision of a Professional Engineer experienced in design of this Work and licensed in the State of Missouri.

1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle packaged materials in original containers with seals unbroken and labels intact until time of use.
- B. Discharge materials carefully and store on clean concrete surface or raised platform in safe, dry area. Do not dump onto ground.

1.07 JOB CONDITIONS

- A. Scheduling, Sequencing:
 - 1. Ensure timely fabrication of items to be embedded, enclosed or incorporated into fabrication/installation of work by other trades.
 - 2. Furnish information and assistance required for locating embedded items and be responsible for proper location.

PART 2 PRODUCTS

2.01 MATERIALS - STEEL

- A. Steel Sections: ASTM A36/A36M; Angles, Channels, Bars, Hot Rolled Shapes: ASTM A992.
- B. Steel Tubing: ASTM A500, Grade B cold-formed structural tubing.

- C. Plates: ASTM A283.
- D. Pipe: ASTM A53/A53M, Grade B Schedule 40, black and hot-dip galvanized finish, as indicated.
- E. Slotted Channel Framing: ASTM A653, Grade 33.
- F. Slotted Channel Fittings: 1.
- G. Fastenings:
 - 1. Typical Unfinished Bolts, Nuts, and Washers: Low carbon steel standard fasteners, externally and internally threaded, ASTM A307; malleable washers.
 - 2. High-Strength Bolts, Nuts, and Washers: ASTM A325 friction or bearing type with threads in shear plane.
 - 3. For Stainless Steel Items: AISI 300 Series stainless steel. Unless otherwise noted, exposed screws shall be Phillips flat head, countersunk.
 - 4. Expansion Anchors: Fed. Spec. FF-S-325, Group II, Type 4. Same as Hilti Fastening Systems "Kwik-Bolt III Concrete Expansion Anchors"; or approved equal. All post installed anchors shall be tested and approved for seismic loading in cracked and uncracked concrete. Provide ICC ESR Report for each product.
- H. Bolts, Nuts, and Washers: 1, Type 1, plain.
- I. Welding Materials: 1; type required for materials being welded.
- J. Shop and Touch-Up Primer: SSPC-Paint 15 - Red Oxide, complying with VOC limitations of authorities having jurisdiction.
- K. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.
- L. Non-Shrink Grout, Non-Metallic: Premixed, pre-packaged, non-metallic, non-shrink grout, requiring only the addition of potable water. Same as Conrad Sovig Co., Inc.'s "Perma Grout"; Master Builders' "Masterflow 928 Grout"; W.R. Meadows, Inc.'s "Sealtight 588 Grout"; Gifford-Hill & Co., Inc.'s "Supreme Grout"; U.S. Grout Corp.'s "Five Star Grout"; or approved equal.

2.02 STANDARD CATALOG PRODUCTS

- A. Architectural Channel Framing System: Channel members and bolted connections with accessories and fittings as noted fabricated to support loads without welded connections. Same as Unistrut Corp.'s "Unistrut, Permagree Finish"; Van Huffel Tube Corp.'s "Power-Strut, Green Enamel Finish"; or Midland-Ross Corp.'s "Super Strut, Goldguard Finish". Numbers noted are "Unistrut" to indicate desired sizes, configurations, and structural requirements. Provide all closures, brackets, bolts, nuts, channels and connectors needed to provide a complete installation.
- B. Aluminum Channel Framing System: Aluminum channel members and bolted connections with accessories and fittings as noted to support loads without welded connections.
 - 1. For use within RF shielded enclosure where channel framing components are indicated.

2.03 MATERIALS - ALUMINUM

- A. Extruded Aluminum: ASTM B221 (ASTM B221M), 6063 alloy, T6 temper.
- B. Sheet Aluminum: ASTM B209/B209M, 5052 alloy, H32 or H22 temper.
- C. Aluminum-Alloy Bars: ASTM B211/B211M, 6061 alloy, T6 temper.
- D. Bolts, Nuts, and Washers: Stainless steel.
- E. Welding Materials: AWS D1.1; type required for materials being welded.

2.04 SPECIALLY FABRICATED PRODUCTS

- A. Preparation:

1. Coordinate with other work supporting or adjoining miscellaneous metal and verify requirements for cutting out, fitting, and attaching.
 2. Verify sizes, designs, and locations of items; do so at site whenever construction progress permits.
- B. General Requirements:
1. Fabricate items from materials noted and make true to profiles shown. Obtain the Architect's approval of proposed variations.
 2. Miter corners and angles of frames and moldings unless otherwise noted.
 3. Perform cutting, shearing, drilling, punching, threading, tapping as required for items or their adjacent work.
 4. Drill or punch holes; do not use cutting torch.
 5. Ensure shearing and punching leaves true lines and surfaces.
 6. Items to be Galvanized: Fabricate in accordance with recommended practices of ASTM A123 unless otherwise noted.
 7. Fabricate exterior items for assembly and installation on site without field-welding of joint.
 8. Ensure metal thickness and assembly details provide ample strength and stiffness.
 9. Size sleeves for approximately 1/4 inch clearance all around.
 10. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.
- C. Fastening:
1. Provide fasteners and anchor assemblies required for complete fabrication, field assembly, and erection.
 2. Conceal fastenings wherever practicable.
 3. Size internally threaded diameters to accommodate galvanized threaded bolts where galvanizing is required.
 4. Permanent Connections in Ferrous Metal Items: Employ welding wherever practicable; avoid bolts and screws.
- D. Welding:
1. Use electric shielded-arc process in accordance with AWS D1.1.
 2. Maintain shape and profile of item welded.
 3. Prevent heat blisters, run-through, and surface distortions.
 4. Exposed Welds: Remove burrs, flux, welding oxide, air spots, and discoloration; grind smooth, polish, or otherwise finish to match material welded.
- E. Bolted, Screwed, and Riveted Connections:
1. Use bolts for field connections only, and then only as noted. Countersink heads; finish smooth and flush.
 - a. Provide washers under heads and nuts bearing on wood.
 - b. Draw nuts tight and prevent loosening of permanent connections by nicking threads.
 - c. Use beveled washers where bearing is on sloped surfaces.
 2. Where necessary to use screws for permanent connections in ferrous metal, use flat head type, countersink, fill screw slots, and finish smooth and flush.
 3. Rivets: Countersink; center heads; machine-drive tight and finish flush and smooth.
 4. Evenly space exposed heads.

2.05 FABRICATED ITEMS

- A. Miscellaneous shapes, plates, angles, tubes and pipe, as required to underpin or otherwise support medical equipment: Fabricate from materials indicated. Provide all clips, bolts, fasteners, shims, etc. to furnish a complete installation.

2.06 FABRICATION

- A. Fit and shop assemble items in largest practical sections, for delivery to site.
- B. Fabricate items with joints tightly fitted and secured.
- C. Continuously seal joined members by intermittent welds and plastic filler or continuous welds.
- D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- E. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.
- F. Furnish components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.07 FINISHES - STEEL

- A. Prime paint steel items.
 - 1. Exceptions: Galvanize items to be embedded in concrete or masonry.
 - 2. Exceptions: Do not prime surfaces in direct contact with concrete, where field welding is required, and items to be covered with sprayed fireproofing.
- B. Completely eliminate burrs, rough spots, and pitting from normally exposed ferrous metal items.
- C. Thoroughly clean surfaces of rust, mill, scale, dirt, grease, and foreign matter prior to finishing.
- D. Prime Painting: One coat.
- E. Painting:
 - 1. Follow paint manufacturer's directions.
 - 2. Permit thorough drying before shipment.
 - 3. Spot paint abrasions and field connections after assembly.
- F. Finish Schedule:
 - 1. Ferrous Metal, Interior Items:
 - a. Concealed: Clean and shop apply one prime coat.
 - b. Exposed: Clean, chemically etch, and shop apply one prime coat.
 - 2. Special Ferrous Metal Items as Noted Below: Clean and hot-dip galvanize in accordance with galvanizing standards. Do not prime coat.
 - a. Exterior lintels.
 - b. Exterior equipment support including all mechanical equipment, ductwork and electrical equipment.
 - 3. Hardware Including Fasteners (Bolts, Nuts, Washers, Etc.):
 - a. Finish to match items fastened.
 - b. Where galvanizing is required, hot-dip galvanize in accordance with ASTM A153.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work.
- B. Do not start installation until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Clean and strip primed steel items to bare metal where site welding is required.
- B. Furnish setting templates to the appropriate entities for steel items required to be cast into concrete or embedded in masonry.

3.03 INSTALLATION

- A. Install items plumb and level, accurately fitted, free from distortion or defects.
- B. Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- C. Field weld components as indicated on drawings.
- D. Perform field welding in accordance with AWS D1.1.
- E. Obtain approval prior to site cutting or making adjustments not scheduled.
- F. After erection, prime welds, abrasions, and surfaces not shop primed or galvanized, except surfaces to be in contact with concrete.
- G. Do not tighten fastener through finish alone without spacer washers.
- H. Provide concrete inserts or pre-drilled expansion anchors in fastening items into concrete.
- I. Protect dissimilar metals from contact with each other or with other materials causing corrosion.
- J. Fasten work tightly to prevent rattle or vibration except where expansion-contraction tolerances are required.
- K. Use non-shrink grout mixed in accordance with manufacturer's directions for setting frames, plates, sills, bolts, and similar items.
- L. Set items shown or required to be installed in sleeves with quick-setting anchor cement unless otherwise noted.
- M. Protect metal from damage to surface, profile, and shape.
- N. Field Touch-Up Painting: After erection, touch-up or paint field connections and abrasions with same paint used for shop painting.

3.04 CLEANING

- A. Remove protective devices only when items will be safe from other construction operations or removal is required to permit related work.
- B. Clean prime coated items as required for finish painting.

3.05 ERECTION TOLERANCES

- A. Tolerances apply unless otherwise noted.
- B. Maximum Variation From Plumb: 1/4 inch (6 mm) per story, non-cumulative.
- C. Maximum Offset From True Alignment: 1/8 inch (3 mm).
- D. Maximum Out-of-Position: 1/8 inch (3 mm).
- E. Architectural Channel Ceiling framing:
 - 1. Maximum Out-of-Level: 1/8 inch (3 mm).

END OF SECTION 05 5000

SECTION 06 1000
ROUGH CARPENTRY

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Rough opening framing for doors, windows, and roof openings.
- B. Items provided by others for installation by carpenters.
- C. Take charge of and distribute hardware at the building and provide and arrange temporary shelving for the storage of all hardware
- D. Installation of all new and reused finish hardware required by the job.
- E. Layout of all partitions, doors, and miscellaneous openings.
- F. Be responsible for establishing all lines and levels for this and other trades.
- G. Erect temporary protection for all completed or partially completed work where required to protect materials, surfaces, finishes and equipment.
- H. Coordinate work and cooperate with all other trades furnishing built-in items, to avoid delays in any work.
- I. Concealed wood blocking for support of toilet and bath accessories, wall cabinets, and furniture systems as required.
- J. Miscellaneous wood nailers, furring, and grounds.

1.02 RELATED REQUIREMENTS

- A. Section 05 5000 - Metal Fabrications: Miscellaneous steel connectors and support angles for miscellaneous framing.
- B. Section 08 1113 - Hollow Metal Doors and Frames: Coordination of layout and rough-in.
- C. Section 08 7100 - Door Hardware: Distribute and coordinate rough-in.
- D. Section 09 2116 - Gypsum Board Assemblies: Gypsum-based sheathing.
- E. Section 09 2216 - Non-Structural Metal Framing: Coordination of layout and blocking.

1.03 REFERENCE STANDARDS

- A. ANSI A208.1 - American National Standard for Particleboard; 2009.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.
- C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.
- D. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation; 2015a.
- E. ASTM C1177/C1177M - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing; 2017.
- F. ASTM C1396/C1396M - Standard Specification for Gypsum Board; 2017.
- G. ASTM D2898 - Standard Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing; 2010 (Reapproved 2017).
- H. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- I. AWPA U1 - Use Category System: User Specification for Treated Wood; American Wood Protection Association; 2012.
- J. PS 1 - Structural Plywood; 2009.

- K. PS 20 - American Softwood Lumber Standard; 2021.
- L. SPIB (GR) - Grading Rules; Southern Pine Inspection Bureau, Inc.; 2014.
- M. WCLIB (GR) - Standard Grading Rules for West Coast Lumber No. 17; West Coast Lumber Inspection Bureau; 2004, and supplements.
- N. WWPA G-5 - Western Lumber Grading Rules; 2021.
- O. FM Global DS 1-49 (Sept. 2009).

1.04 SUBMITTALS

- A. See Special Conditions - Submittals, for submittal procedures.
- B. Product Data: Provide technical data on wood preservative materials and application instructions.
- C. Manufacturer's Certificate: Certify that wood products supplied for rough carpentry meet or exceed specified requirements.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation within and around stacks while under temporary coverings including polyethylene or similar material.
 - 1. For lumber and plywood pressure treated with waterborne chemicals, place spacers between each bundle to provide air circulation
- B. Fire Retardant Treated Wood: Prevent exposure to precipitation during shipping, storage, and installation.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.
 - 1. Species: Southern Pine, Douglas Fir, or Southern Yellow Pine, unless otherwise indicated.
 - 2. If no species is specified, provide species graded by the agency specified; if no grading agency is specified, provide lumber graded by grading agency meeting the specified requirements.
 - 3. Grading Agency: Grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee at www.alsc.org, and who provides grading service for the species and grade specified; provide lumber stamped with grade mark unless otherwise indicated.
 - 4. Lumber of other species or grades is acceptable provided structural and appearance characteristics are equivalent to or better than products specified.
- B. Lumber fabricated from old growth timber is not permitted.

2.02 DIMENSION LUMBER FOR CONCEALED APPLICATIONS

- A. Grading Agency: Western Wood Products Association; WWPA G-5.
- B. Sizes: Nominal sizes as indicated on drawings, S4S, rough (unsurfaced).
- C. Moisture Content: S-dry or MC19.
- D. Miscellaneous Framing, Blocking, Nailers, Grounds, and Furring:
 - 1. Lumber: S4S, Construction Grade, No. 2 Grade Fire treated Douglas Fir or Southern Yellow Pine.
 - 2. Boards: Standard grade fire treated Douglas Fir or Southern Yellow Pine.

2.03 CONSTRUCTION PANELS

- A. Communications and Electrical Room Mounting Boards: PS 1 A-D plywood; 3/4 inch (19 mm) thick; flame spread index of 25 or less, smoke developed index of 450 or less, when tested in accordance with ASTM E 84.
- B. Other Applications:
 - 1. Plywood Concealed From View But Located Within Exterior Enclosure: 1, C-C Plugged or better, Exterior grade.
 - 2. Plywood Exposed to View But Not Exposed to Weather: 1, A-D, or better.
 - 3. Other Locations: 1, C-D Plugged or better.

2.04 ACCESSORIES

- A. Rough Hardware: All exterior hardware shall be hot-dipped galvanized.
 - 1. Nails: Common wire galvanized, typical.
 - 2. Bolts: Hexagonal heads, Grade A conforming to ASTM A307.
 - 3. Washers: Washers for bearing against wood shall be provided under all bolt heads and nuts. Malleable iron or steel plate having an area equal to 16 times the area of bolt or lag screw. Steel washers shall have a thickness not less than 1/10 the length of the washer's longest side. Malleable iron washers shall have a thickness not less than 1/2 the bolt or lag screw diameter and having a bearing surface for the nut or head equal in diameter to not less than the long diameter of the nut or head.
 - 4. Screw Fasteners: ASTM C1002, self-drilling, self-tapping, corrosion-resistant type.
 - 5. Powder Driven Fasteners: Tempered steel pins with special corrosive-resistant plating or coating. Pins shall have guide washers to accurately control penetration, maximum 3/4 inch. Fastening shall be accomplished by low-velocity piston-driven powder-actuated tool. Pins and tool shall be same as manufactured by Hilti Fastening Systems; Impex Tool Corp.; or approved equal.
 - 6. Expansion Anchors: Fed. Spec. FF-S-325, Group II, Type 4. Same as Hilti Fastening Systems "Kwik-Bolt III Concrete Expansion Anchors and Hilti Drop-In Anchors"; Wej-It Expansion Products, Inc.'s "Wej-It Concrete Anchors and Wej-It Drop-In Anchors"; or approved equal.
- B. Fasteners and Anchors:
 - 1. Metal and Finish: Hot-dipped galvanized steel complying with 1 for high humidity and preservative-treated wood locations, unfinished steel elsewhere.
 - 2. Drywall Screws: Bugle head, hardened steel, power driven type, length three times thickness of sheathing.
 - 3. Anchors: Toggle bolt type for anchorage to hollow masonry.

2.05 FACTORY WOOD TREATMENT

- A. Treated Lumber and Plywood: Comply with requirements of 1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.
 - 1. Fire-Retardant Treated Wood: Mark each piece of wood with producer's stamp indicating compliance with specified requirements.
 - 2. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWWA standards.
- B. Fire Retardant Treatment: AWWA Treatment U1, Interior Type, Class A, Low Hygroscopic, chemical treatment pressure impregnated; same as Pyro-Guard manufactured by Hoover Treated Wood Products, Inc.

- C. Preservative Pressure Treatment of Lumber Above Grade: AWWA Use Category UC3B, Commodity Specification A (Treatment C2) using waterborne preservative.
 - 1. Kiln dry lumber after treatment to maximum moisture content of 19 percent.
 - a. Treat lumber exposed to weather.
 - 2. Treat lumber in contact with roofing, flashing, and waterproofing.
 - 3. Treat lumber in contact with masonry and concrete.
 - 4. Treat lumber less than 18 inches (450 mm) above grade.

2.06 FABRICATION

- A. Lumber:
 - 1. Air- or kiln-dry to maximum 19 percent moisture content, except maximum 15 percent for two inch lumber at time of surfacing.
 - 2. Furnish S4S unless otherwise noted.
 - 3. Size to conform with rules of governing standard. Sizes shown are nominal unless otherwise noted.
- B. Wood Treatments:
 - 1. Fire-Retardant Treatment:
 - a. Lumber: Treat in accordance with AWWA U1.
 - b. Plywood: Treat in accordance with AWWA U1.
 - 2. After treatment and prior to shipping, air- or kiln-dry lumber to maximum 12 percent moisture content.

2.07 SOURCE QUALITY CONTROL

- A. Lumber shall bear grade-trademark or be accompanied by certificate of compliance of appropriate grading agency.
- B. Plywood shall bear APA grade-trademark.

PART 3 EXECUTION

3.01 PREPARATION

- A. Examine areas to receive rough carpentry work and verify following:
 - 1. Installation of building components to receive rough carpentry work is complete.
 - 2. That surfaces are satisfactory to receive work.
 - 3. That spacing, direction, and details of supports are correct to accommodate installation of blocking, backing, stripping, furring, and nailers.
- B. Coordinate installation of rough carpentry members specified in other sections.

3.02 INSTALLATION - GENERAL

- A. Select material sizes to minimize waste.
- B. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.
- C. Where treated wood is used on interior, provide temporary ventilation during and immediately after installation sufficient to remove indoor air contaminants.
- D. Cutting: Perform major cutting, boring, etc., and work affecting finish carpentry.
- E. Drop-In Expansion Anchors: Use for floor installation only. NOT permitted for use in overhead or vertical surfaces.

3.03 BLOCKING, NAILERS, AND SUPPORTS

- A. Provide framing and blocking members as indicated or as required to secure and support finishes, fixtures, specialty items, trim and other work.

- B. Where indicated in metal stud walls, provide continuous blocking around door and window openings for anchorage of frames, securely attached to stud framing.
- C. In walls, provide blocking attached to studs as backing and support for wall-mounted items.
- D. Where ceiling-mounting is indicated, provide blocking and supplementary supports above ceiling, unless other method of support is explicitly indicated.
- E. Provide the following specific nonstructural framing and blocking:
 - 1. Cabinets and shelf supports.
 - 2. Wall brackets.
 - 3. Handrails.
 - 4. Grab bars.
 - 5. Towel and bath accessories.
 - 6. Wall-mounted door stops.
 - 7. Chalkboards and marker boards.

3.04 INSTALLATION OF CONSTRUCTION PANELS

- A. Communications and Electrical Room Mounting Boards: Secure with screws to studs with edges over firm bearing; space fasteners at maximum 24 inches (610 mm) on center on all edges and into studs in field of board.
 - 1. At fire-rated walls, install board over wall board indicated as part of the fire-rated assembly.
 - 2. Where boards are indicated as full floor-to-ceiling height, install with long edge of board parallel to studs.
 - 3. Install adjacent boards without gaps.
 - 4. Size: 48 by 96 inches (2440 by 4880 mm), installed horizontally at ceiling height.
 - 5. Size and Location: As indicated on drawings.

3.05 SITE APPLIED WOOD TREATMENT

- A. Apply preservative treatment compatible with factory applied treatment at site-sawn cuts, complying with manufacturer's instructions.
- B. Allow preservative to dry prior to erecting members.

3.06 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements for additional requirements.
- B. Coordination of ABAA Tests and Inspections:
 - 1. Provide testing and inspection required by ABAA QAP.
 - 2. Notify in ABAA writing of schedule for air barrier work. Allow adequate time for testing and inspection.
 - 3. Cooperate with ABAA testing agency.
 - 4. Allow access to air barrier work areas and staging.
 - 5. Do not cover air barrier work until tested, inspected, and accepted.

3.07 CLEANING

- A. Waste Disposal:
 - 1. Comply with applicable regulations.
 - 2. Do not burn scrap on project site.
 - 3. Do not burn scraps that have been pressure treated.
 - 4. Do not send materials treated with pentachlorophenol, CCA, or ACA to co-generation facilities or "waste-to-energy" facilities.
- B. Do not leave wood, shavings, sawdust, etc. on the ground or buried in fill.
- C. Prevent sawdust and wood shavings from entering the storm drainage system.

END OF SECTION 06 1000

MU PROJECT NO. CP245321
OWH PROJECT NO. 2498000

Patient Care Tower - T1230 MRI Room
Bid Package
July 9, 2024

SECTION 06 2000
FINISH CARPENTRY

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Work Included in this Section: Provision of finish carpentry items including, but not necessarily limited to, the following:
 - 1. Exposed hardwood blocking, cleats and ledgers for countertops and casework.
- B. Installation of materials and systems but not necessarily limited to the following:
 - 1. Installation of plastic laminate countertops / splashes.
 - 2. Installation of plastic laminate casework and associated vertical valance trim.
 - 3. Installation of miscellaneous plastic laminate items and related accessories including, but not necessarily limited to:
 - a. Shelving and supports.
 - 4. Installation of corner guards, edge guards, handrails and crashrails.
 - 5. Installation of solid polymer countertops/surfaces.
 - 6. Installation of solid polymer countertops / window sills.
 - 7. Related hardware and accessories.

1.02 RELATED SECTIONS

- A. Section 01 6000 - Product Requirements.
- B. Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- C. Section 06 1000 - Rough Carpentry: Fire treated backing in walls.
- D. Section 06 4130 - Custom Plastic Laminate Casework.
- E. Section 07 9200 - Joint Sealants.
- F. Section 09 2216 - Non-Structural Metal Framing: Metal plate backing.
- G. Section 10 2601 - Wall and Corner Guards.

1.03 REFERENCES

- A. 1 - Standard Grading Rules for West Coast Lumber No. 17; 2004, and supplements.
- B. WWPA G-5 - Western Lumber Grading Rules; 2011.
- C. 1- Rules for the Measurement & Inspection of Hardwood & Cypress; National Hardwood Lumber Association; 2015.
- D. 1 - Standard Grading Rules for Canadian Lumber; 2017.
- E. 1 - Use Category System: User Specification for Treated Wood; 2012.

1.04 SUBMITTALS

- A. See Special Conditions - Submittals, for submittal procedures.
- B. Product Data.
- C. Samples: Only as requested.
- D. Shop Drawings:
 - 1. Show fabrication, installation, and anchorage details.
 - 2. Show all details full size.
- E. Product Data: For each type of process and factory-fabricated product. Include construction details, material descriptions, dimensions of individual components and profiles, textures, and colors.

1.05 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit work to be performed according to manufacturer's written instructions and warranty requirements and at least one coat of specified finish to be applied without exposure to rain, snow, or dampness.

PART 2 PRODUCTS

2.01 MATERIALS

- A. General:
 - 1. Material Grades: Architectural Woodwork Institute (AWI) Premium Grade unless otherwise noted.
 - 2. Lumber and plywood shall be kiln-dried to equilibrium moisture content suitable for fabrication in shop and suitable for use intended.
 - 3. Lumber fabricated from old growth timber is not permitted.
- B. Wood Items:
 - 1. Hardwood Blocking, Cleats, Ledgers: Paint grade poplar or birch.
- C. Miscellaneous Steel Supports: Meet requirements of Metal Fabrications Section for materials, fabrication, and finishing.
- D. Fasteners:
 - 1. Nails, Typical Interior: Common wire galvanized.
 - 2. Screws: Self-drilling and self-tapping type, size as noted. Same as Buildex's "TEKS Fasteners"; The Rawlplug Co., Inc.'s "Rawl Self-Drilling Screws"; or approved equal.
 - 3. Screws, Trim Head: Self-drilling, self-tapping screws with trim head for attaching wood trim to steel framing. Same as US Gypsum Co.'s "USG Trim Head Screws, Wood Trim to Interior Steel Framing Type"; Buildex's "Hi-Lo Drywall Screw, Trim Head"; or approved equal.
 - 4. Expansion Bolts: Fed. Spec. FF-S-325, Group II, Type 4, size as noted. Same as Hilti Fastening Systems "Kwik-Bolt III Concrete Expansion Anchors"; Wej-It Expansion Products, Inc.'s "Wej-It Concrete Anchors"; or approved equal.
- E. Fire Retardant: Formulation yielding performance rating results stipulated as acceptable under AWPA U1.
- F. Backprime: Clear lacquer sanding sealer. Same as The Glidden Co.'s No. 6059; Pratt and Lambert, Inc.'s No. C101-6; or approved equal.

2.02 FABRICATION

- A. Preparation:
 - 1. Verify dimensions of receiving spaces at job site.
 - 2. Verify details and dimensions of equipment and fixtures integral with finish carpentry for proper fit and accurate alignment.
 - 3. Coordinate details with other work supporting, adjoining, or fastening to finish carpentry items.
- B. Fire-Retardant Treatment: Apply to interior lumber in accordance with AWPA U1 and to plywood in accordance with AWPA U1.
- C. General:
 - 1. Fabricate finish carpentry in accordance with AWI Premium grade unless otherwise noted.
 - 2. Kerf backs of solid members more than five inches wide or more than one inch nominal thickness.
- D. Backprime: Apply to wood surfaces to be installed against concrete, masonry, or plaster.

PART 3 EXECUTION

3.01 INSPECTION

- A. Examine surfaces scheduled to receive finish carpentry for conditions that will adversely affect installation.
- B. Do not install work until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Clean substrates of projections and substances detrimental to application.
- B. Prime lumber for exterior applications to be painted, including both faces and edges. Cut to required lengths and prime ends. Comply with requirements in Division 9 Section "Painting".

3.03 INSTALLATION, INTERIOR

- A. Set work square, level, and plumb with edges scribed accurately; secure in place with fastenings, clips, braces, brackets, anchors, shims, and blocks.
- B. Coordinate finish carpentry work with partition construction and blocking requirements for the placement and installation of items fastening to partitions.
- C. Conceal nailing where possible and set nail heads for putty in exposed portions.
- D. Thoroughly hand sand wood surfaces. Take care that cross sanding is removed by final sanding in direction of grain; ease "knife-edge" corners by sanding. Wood surfaces shall be free from dust, glue, stains, and other foreign matter and in proper condition to receive finish.
- E. Reference Section 10 2601: Wall and Corner Guards for installation requirements regarding corner guards, edge guards, wall protection, etc.

3.04 ADJUSTING

- A. Replace finish carpentry that is damaged or does not comply with requirements. Finish carpentry may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing. Adjust joinery for uniform appearance.

3.05 CLEANING AND PROTECTION

- A. Protect installed casework/millwork from subsequent construction operations.
- B. Clean finish carpentry on exposed and semiexposed surfaces. Touch up factory-applied finishes to restore damaged or soiled areas.

END OF SECTION 06 2000

SECTION 06 4130
CUSTOM PLASTIC LAMINATE CASEWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Architectural woodwork items including but not necessarily limited to the following.
 - 1. Finish carpentry items and related accessories:
 - a. Exposed hardwood blocking, cleats, and ledgers for shelves and countertops.
 - 2. Custom plastic laminate casework and related accessories.
 - 3. Plastic laminate countertops and splashes.
 - 4. Miscellaneous plastic laminate items and related accessories including, but not necessarily limited to:
 - a. Shelving and supports.
 - b. Plastic laminate closure panels at the top of new and existing casework.
 - 5. Architectural woodwork hardware and accessories.
 - 6. Metal countertop supports.
 - 7. Solid polymer countertops, splashes, caps and window trim at MRI Control window.
- B. Related Work Not Included in this Section:
 - 1. Mechanical and electrical fixtures and fittings for elements located in architectural woodwork including rough-in and connection to such fixtures.
 - 2. Resilient bases.
 - 3. Backing in walls for anchoring architectural woodwork items.
 - 4. Glass and glazing except as noted above.
 - 5. Transparent finishing.
- C. Definitions for Casework Items:
 - 1. Exposed Surfaces: Visible surfaces of units when doors, drawers, or other closures are in closed position; visible exterior and interior surfaces of units without closures; visible surfaces behind clear glass doors; bottoms of units more than 4 feet above floor; closure fronts and edges; and counter tops and splashes including their edges.
 - 2. Semi-Exposed Surfaces: Visible interior surfaces of units when closures are in open position; surfaces & edges of shelves; interior surfaces of doors & drawers; bottoms of wall hung units 4 feet or less above floor; & tops of units 6 feet 6 inches or more above floor.
 - 3. Concealed Surfaces: All surfaces other than exposed or semi-exposed as defined above.

1.02 RELATED SECTIONS

- A. Section 01 6000 - Product Requirements.
- B. Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- C. Section 05 5000 - Metal Fabrications: Metal brace/bracket for countertops.
- D. Section 06 1000 - Rough Carpentry: Backing in walls for anchoring plastic laminate casework items.
- E. Section 06 2000 - Finish Carpentry: Installation associated with plastic laminate casework.
- F. Section 07 9200 - Joint Sealants.
- G. Section 09 6500 - Resilient Flooring: Resilient base.
- H. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables: Electrical rough-in/fittings/connections for items installed in casework.

1.03 REFERENCES

- A. ANSI A135.4 - American National Standard for Basic Hardboard; 2012.

- B. ANSI A208.1 - American National Standard for Particleboard; 2009.
- C. ANSI A208.2 - American National Standard for Particleboard for Medium Density Fiberboard for Interior Use; 2009.
- D. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards, U.S. Version 3.0; 2016. with Errata (2017).
- E. BHMA A156.9 - American National Standard for Cabinet Hardware; Builders Hardware Manufacturers Association, Inc.; 2015 (ANSI/BHMA A156.9).
- F. HPVA HP-1 - American National Standard for Hardwood and Decorative Plywood; Hardwood Plywood & Veneer Association; 2016.
- G. NEMA LD 3 - High-Pressure Decorative Laminates; National Electrical Manufacturers Association; 2005.
- H. NHLA G-101 - Rules for the Measurement & Inspection of Hardwood & Cypress; 2015.
- I. PS 1 - Structuralo Plywood; 2009.
- J. PS 20 - American Softwood Lumber Standard; 2010.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than five (5) years of documented experience.
- B. Fabricator Qualifications: Fabricator shall be equipped for and experienced in doing work including fabricating, finishing, and installing equal to standards specified, and shall be able to provide evidence of such experience to the Architect's satisfaction.

1.05 SUBMITTALS

- A. See Special Conditions - Submittals, for submittal procedures.
- B. Product Data.
- C. Samples:
 - 1. Plastic laminate for color and pattern selection.
 - 2. Hardwood receiving transparent finish.
 - 3. Solid polymer samples for color selection.
 - 4. Other samples only as requested.
- D. Shop Drawings:
 - 1. Show fabrication, installation, and anchorage details.
 - 2. Show all details full size.

1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver architectural woodwork items to job site only after proper facilities are available for handling, storing, and protecting items; receiving areas are broom cleaned; exterior openings are closed up; wet work and mechanical and electrical rough-ins are completed.
- B. Provide temporary protective covers for items during delivery, installation, and until final acceptance of Project.

1.07 JOB CONDITIONS

- A. Environmental Requirements:
 - 1. Finishing: Apply finishes under adequate lighting conditions and maintain temperature near 70 degrees Fahrenheit during application.
 - 2. Provide proper heat and humidity in area of storage and installation to maintain equilibrium moisture content in wood until installation is completed. Relative humidity shall range from 50 percent to 65 percent at 70 degrees Fahrenheit.

- B. Sequencing: Provide information as required for proper placement of backing.
- C. Protection: Protect installation from damage until the Owner's final acceptance.

1.08 PRE-INSTALLATION MEETING

- A. Convene one week before starting work of this section.

PART 2 PRODUCTS

2.01 MATERIALS

- A. General Requirements:
 - 1. Material Grades: AWI Premium grade unless otherwise noted.
 - 2. Lumber and plywood shall be kiln-dried to equilibrium moisture content suitable for fabrication in shop and suitable for use intended.
 - 3. Lumber fabricated from old growth timber is not permitted.
- B. Wood Items:
 - 1. Hardwood Blockings, Cleats and Ledgers: Paint grade poplar or birch.
- C. Base Material for Plastic Laminate:
 - 1. Panel Core (Particleboard): A mat-formed flat panel consisting of particles of wood bonded together with a synthetic resin or other suitable binder, compressed to proper density and cured under heat and pressure. Particleboard shall meet the requirements of ANSI A208.1, Table 1 Grade 1-M-3.
 - 2. Water Resistant Core (at countertops with sinks and window stools): Industrial Grade Medium Density (MDF) fiberboard with a formaldehyde free binder meeting the requirements of ANSI A208.2.94. Same as Medite "Medex".
 - 3. Lumber (Solid Stock): Gum, Birch, or Sugar Pine.
- D. Plastic Laminate:
 - 1. Typical: Solid color, textured, high pressure laminate, general purpose grade. Same as Formica Corp.'s "Formica, Matte"; Nevamar Corp.'s "Textured"; Ralph Wilson Plastics "Wilsonart, Velvet"; or approved equal.
 - 2. Cladding Materials:
 - a. Cladding materials for exposed surfaces:
 - 1) Horizontal (non-counter) surfaces: Grade HGS (1.2 mm nominal thickness).
 - 2) Postformed surfaces: Grade HGP (1.0 mm nominal thickness).
 - 3) Vertical surfaces: Grade HGS (1.2 mm thickness for high impact areas) or Grade VGS (0.7 mm thickness for low impact areas).
 - 4) Pattern direction: Vertically for drawer fronts, doors, and fixed panels.
 - b. Cladding materials for semi-exposed surfaces:
 - 1) Surfaces other than drawer bodies: High-pressure decorative laminate, NEMA LD 3, Grade CLS (0.5 mm nominal thickness).
 - 2) Door and drawer edges: Minimum 1 mm PVC or polyester edge banding color-matched to plastic laminate.
 - 3) Drawer sides and backs: Thermoset (melamine) decorative panels.
 - 4) Drawer bottoms: Thermoset (melamine) decorative panels.
 - 3. Adhesive for Laminating Plastic: As recommended by approved plastic laminate manufacturer.
- E. Typical Countertop Supports: Extruded aluminum, same as RAKKS EH, FM (flushmount), length x height as indicated on drawings or if not indicated, 25 required to support surface.
 - 1. At locations where undercounter surface mounted wire mold is installed (Control Room), Contractor to provide recess mount brackets, same as RAKKS Inside Wall EH Support Bracket FM.

- F. Backprime: Clear lacquer sanding sealer. Same as The Glidden Co.'s No. 6059; Pratt and Lambert, Inc.'s No. C101-6; or approved equal.
- G. Fasteners:
 - 1. Typical Unfinished Bolts, Lag Bolts (Lag Screws), Nuts, and Washers: Low carbon steel standard fasteners, externally and internally threaded, ASTM A307; malleable washers.
 - 2. Nails, Typical Interior: Common wire galvanized, typical.
 - 3. Exposed Nails and Fastenings for Exterior Use: Aluminum or stainless steel.
 - 4. Screws: Self-drilling and self-tapping type, size as noted. Same as Buildex's "TEKS Fasteners"; The Rawlplug Co., Inc.'s "Rawl Self-Drilling Screws"; or approved equal.
 - 5. Screws, Trim Head: Self-drilling, self-tapping screws with trim head for attaching wood trim to steel framing. Same as US Gypsum Co.'s "USG Trim Head Screws, Wood Trim to Interior Steel Framing Type"; Buildex's "Hi-Lo Drywall Screw, Trim Head"; or approved equal.
 - 6. Expansion Anchors: Fed. Spec. FF-S-325, Group II, Type 4, size as noted. Same as Hilti Fastening Systems "Kwik-Bolt III Concrete Expansion Anchors"; Wej-It Expansion Products, Inc.'s "Wej-It Concrete Anchors"; or approved equal.
- H. Architectural Woodwork Accessories:
 - 1. PVC Edge (Countertops): High impact rigid 3.0 mm PVC vinyl; 1-1/2 inch (38 mm). Custom color to match adjacent plastic laminate.
 - 2. PVC Edge (Drawers/Doors): High impact 3.0 mm PVC vinyl; custom color to match adjacent plastic laminate.
 - 3. Grommets (Color as selected by Architect):
 - a. Type 1: Vinyl type, 2 inch diameter. Same as Doug Mockett & Co., Inc.'s "TG Series with Covers"; or approved equal. Provide unless noted otherwise.
 - 1) Contractor to provide grommets at 4'-0" O.C. at all countertops containing open knee space with a minimum of one grommet per countertop, unless otherwise noted. Coordinate location with Owner / Architect.
- I. Architectural Woodwork Hardware:
 - 1. General Requirements:
 - a. Exposed Casework Hardware Finish: BHMA 630f (Satin Stainless Steel), unless otherwise noted.
 - b. Furnish necessary screws, staples, bolts, or other fastenings of proper size and type to secure items in position where exposed, to match finish of hardware item fastened.
 - c. Hinges: Provide frameless concealed hinges (European Type) in accordance with BHMA A156.9, B01602, self-closing type.
 - d. Pulls: In most instances, pulls are to be back mounted, solid metal, wire type. Coordinate with project specific requirements and entity requirements for specific exceptions.
 - e. Catches are not required for typical installations unless specific design conditions require otherwise.
 - f. Adjustable Shelf Standards and Supports in accordance with BHMA A156.9, B04071. Shelf rests shall be in accordance with B04081.
 - g. Drawer Slide: Drawer slides shall be in accordance with BHMA A156.9. Grade 1 (50lbf) and Grade 2 (30 lbf) are side mounted, extend under bottom edge of drawer, full-extension, zinc-plated steel with polymer rollers. Grade 1HD-100 (100 lbf) and Grade 1HD-200 (200 lbf) are heavy duty type, side mounted, full-extension, zinc-plated-steel ball-bearing slides. The following conditions are considered to be minimum requirements for the applications identified. A higher grade may be required based on intended use.

- 1) For drawers less than 3 inches (75 mm) high and not more than 24 inches (600 mm) wide, provide Grade 2.
 - 2) For drawers at least 3 inches (75 mm) high and not more than 6 inches (150 mm) high and not more than 24 inches (600 mm) wide, provide Grade 1.
 - 3) For drawers more than 6 inches (150 mm) high or more than 24 inches (600 mm) wide, provide Grade 1HD-100.
 - 4) For computer keyboard shelves, provide Grade 1HD-100.
 - 5) For trash bins not more than 20 inches (500 mm) high and 16 inches (400 mm) wide, provide Grade 1HD-200.
 - h. Door Locks: In accordance with BHMA A156.11, E07121.
 - i. Drawer Locks: In accordance with BHMA A156.11, E07041.
 - j. Door and Drawer Silencers: In accordance with BHMA A156.16, L03011.
 - k. Keying: Casework locks within each department shall be keyed alike but keys of one department shall not permit access to another department's locks. Refer to casework drawing elevations for lock locations. Coordinate with the Owner for detailed keying instructions.
2. Drawers - Each to Have:
 - a. Pair Metal Extension Guides:
 - 1) Typical: Same as Knape and Vogt Mfg. Co.'s No. 1300; Grant Hardware Co.'s No. 338; or approved equal.
 - 2) "Pencil" Drawer: Same as Grant Hardware Co.'s No. 354; or approved equal.
 - b. Pull (two where more than 20 inches wide): Same as Ives No. 37; The Stanley Works' No. 4483-1/2; or approved equal.
 - c. Lock and Strike (where noted): Same as National Lock Co.'s No. 68-3718; Corbin Cabinet Lock No. 07638; or approved equal.
 3. Keyboard Tray: O.F.O.I. Contractor to provide 3/4" plywood blocking at locations noted on drawings.
 4. Hinged Doors (3/4 inch thick) - Each Leaf to Have:
 - a. Pair Concealed Hinges (1-1/2 pairs where more than 48 inches high): 176 degrees opening, self closing type. Same as The Stanley Works' No. 1511-2 and 1511-9X; Grass America, Inc.'s No. 1200 and 1201; or approved equal.
 - b. Pull: Same as drawers.
 - c. Catch: Same as Hager Hinge Co.'s No. 1438; The Stanley Works' No. SP42; or approved equal.
 - d. Lock and Strike (where noted): Same as Corbin Cabinet Lock No. 0737; National Lock Co.'s No. 68-3713; or approved equal.
 5. Typical Adjustable Shelves:
 - a. Standards: Same as Knape and Vogt Mfg. Co.'s No. 255; Grant Hardware Co.'s No. 120; or approved equal.
 - b. Supports: Same as Knape and Vogt Mfg. Co.'s No. 256; Grant Hardware Co.'s No. 21; or approved equal.
 6. Wall-Mounted Adjustable Shelves:
 - a. Standards: Same as Knape and Vogt Mfg. Co.'s No. 87; or approved equal.
 - b. Supports: Same as Knape and Vogt Mfg. Co.'s No. 187; or approved equal.
 - c. Shelf Rests: Same as Knape and Vogt Mfg. Co.'s No. 211; or approved equal.
 7. Shelf Supports or Brackets: Same as Knape and Vogt Mfg. Co.'s No. 204; or approved equal.
 8. Bench Top Lid Stay: Same as Hafele's "Beroline Lid Stay," size as required for bench top lid. Provide (2) units per bench top.

- J. Solid Polymer (Countertops/Splashes/Trim): Cast filled acrylic; not coated, laminated or of coocomposite construction, meeting ANSI Z124, type 6. Same as DuPont's "Corian"; Wilsonart, "Mystique"; or approved equal.
 - 1. Countertop/Splash/Trim: 1/2 inch thick lavatory top laminated to minimum 3/4" inch medium density fiberboard (water resistand core). Provide complete with splash and fascia as detailed.
 - 2. Color Range: Color as selcted by Architect from DuPont's Corian for pricing purposes use "Sonora (E)."
 - 3. Joint Adhesive: Manufacturer's standard two-part adhesive hit to create inconspicuous, non-porous joints.
 - 4. Sealant: Manufacture's standard mildew resistant, FDA/UL recognized silicone sealant in color to match color of solid polymer.

2.02 FABRICATION

- A. Preparation:
 - 1. Verify dimensions of receiving spaces at job site.
 - 2. Verify details and dimensions of equipment and fixtures integral with architectural woodwork for proper fit and accurate alignment.
 - 3. Coordinate details with other work supporting, adjoining, or fastening to architectural woodwork.
- B. General:
 - 1. Fabricate architectural woodwork in accordance with AWI Premium grade specifications unless otherwise noted.
 - 2. Fabricate miscellaneous plastic laminate items in accordance with AWI Premium grade specifications unless otherwise noted.
 - 3. Shop fabricate and assemble complete work in complete units insofar as dimensions permit shipment and installation.
 - 4. Provide space at rear of casework where required for mechanical and electrical fittings.
 - 5. Provide cut-outs as required for mechanical, electrical, and telephone installation.
 - 6. Conceal nailing where possible and set nail heads for putty on exposed portions.
 - 7. Provide for concealed anchorage of tops and splashes.
 - 8. Thoroughly hand sand wood surfaces. Take care that cross sanding is removed by final sanding in direction of grain; ease "knife-edge" corners by sanding. Wood surface shall be free from dust, glue, stains, and other foreign matter and in proper condition to receive finish.
- C. Plastic Laminate:
 - 1. Laminate plastic under pressure in accordance with AWI Premium grade requirements.
 - 2. Apply plastic laminate to all exposed and semi-exposed surfaces unless otherwise noted.
 - 3. Application of casework liner or polyester-surfaced flakeboard to semi-exposed casework surfaces will not be permitted.
 - 4. Do not expose edges on face of casework.
 - 5. Compensate laminate on one face of base material with laminate balancing sheet on opposite face.
 - 6. Countertops/Splashes: Provide backer sheet on underside of all countertops and back of splashes, regardless of core thickness or unsupported area. In all other respects, meet requirements of AWI premium grade.
 - 7. Provide acid resistant type laminate at all horizontal surfaces, unless otherwise noted.
 - 8. Fabricate all counters at sinks, wet areas, and window stools with industrial grade medium density fiberboard with a formaldehyde free binder.
 - 9. Interior faces of drawers shall be covered with plastic laminate balancing sheet or cabinet liner.

10. Interior faces of hinged doors shall be covered with plastic laminate cabinet liner.
 11. Interior face of sliding doors shall be covered with plastic laminate cabinet liner.
- D. Solid Polymer:
1. Factory fabricate components to greatest extent possible to size and profiles indicated.
 2. Form joints using manufacturer's standard joint adhesive, joints shall provide a 'seamless' look.
 3. Provide factory cutouts for plumbing fittings and accessories. Coordinate with plumbing scope of work.
 4. Cut and finish edges with clean, sharp returns.
- E. Glass and Glazing:
1. Meet the requirements of Section 08800 - Glazing.
 2. All glass and glazing shall be tempered and/or safety glass.
- F. Backprime: Apply to wood surfaces to be installed against concrete, masonry, or plaster.
- G. Ease and grind smooth all edges. Curve or round corners where noted.
- H. Accessory Hardware: Make provision in accordance with requirements of items scheduled.
- I. Architectural Woodwork Hardware:
1. Make provisions in accordance with approved hardware manufacturer's templates.
 2. Fit hardware to casework and attach for smooth, trouble-free non-binding operation using hardware manufacturer's approved fasteners.

PART 3 EXECUTION

3.01 INSPECTION

- A. Examine areas scheduled to receive architectural woodwork for conditions that will adversely affect installation.
- B. Do not install items before unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install architectural woodwork in accordance with AWI Premium grade standards and reviewed Shop Drawings.
- B. Set work square, level, and plumb with edges scribed accurately and secure in place with fastenings, clips, braces, anchors, shims, and blocks.
- C. Coordinate architectural woodwork items with partition construction for the placement and installation of items fastening to partitions.
- D. Conceal nailing where possible and set nail heads for putty in exposed portions.
- E. Thoroughly hand sand wood surfaces. Take care that cross sanding is removed by final sanding in direction of grain; ease "knife-edge" corners by sanding. Wood surfaces shall be free from dust, glue, stains, and other foreign matter and in proper condition to receive finish.
- F. Miter inside and outside corners of trims.
- G. Solid Polymer:
 1. Install components plumb and level, scribed to adjacent finishes.
 2. Form field joints using manufacturer's recommended adhesive. Joints shall be inconspicuous. Keep components and hands clean while making joints.
 3. Adhere backsplash to top using manufacturer's standard color-matched silicone sealant.

3.03 CLEANING AND ADJUSTING

- A. Remove damaged/soiled/otherwise disfigured portions and replace with new prior to final acceptance.

- B. Wash finished work in strict accordance with product manufacturer's directions and ensure that washed surfaces do not differ from clean unwashed portions. Any difference will be considered unsatisfactory work.

END OF SECTION 06 4130

SECTION 07 5300
ELASTOMERIC MEMBRANE ROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Cutting and patching of insulation, flat and tapered.
- B. Cutting and patching of elastomeric roofing membrane, fully adhered conventional application.
- C. Vapor retarder.
- D. Membrane flashings and related accessories.
- E. Roof walkway pads.

1.02 RELATED REQUIREMENTS

- A. Section 06 1000 - Rough Carpentry: Wood nailers, curbs, and wood cant strips.
- B. Section 07 6200 - Sheet Metal Flashing and Trim: Counterflashings, reglets and flashings.
- C. Division 23 - For Mechanical Equipment on Roof.
- D. Division 26 - For Electrical Equipment on Roof.

1.03 REFERENCE STANDARDS

- A. 11
- B. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers--Tension; 2016 (Reapproved 2021).
- C. 11
- D. ASTM D624 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers; 2000 (Reapproved 2020).
- E. ASTM D746 - Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact; 2020.
- F. ASTM D2240 - Standard Test Method for Rubber Property--Durometer Hardness; 2015 (Reapproved 2021).
- G. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2010.
- H. FM Approval Guide; Factory Mutual Research Corporation; current edition.
- I. FM DS 1-28 - Wind Design; Factory Mutual Research Corporation; 2007.
- J. NRCA ML104 - The NRCA Roofing and Waterproofing Manual; Fifth Edition, with interim updates.
- K. UL (DIR) - Online Certifications Directory; Current Edition.
- L. UL (FRD) - Fire Resistance Directory; Current Edition.

1.04 SUBMITTALS

- A. See Special Conditions - Submittals, for submittal procedures.
- B. Submit written statement that roofing membrane is compatible with insulation material.
- C. Product Data: Provide data indicating membrane materials, flashing materials, fasteners, and accessories.
- D. Shop Drawings: Indicate joint or termination detail conditions, conditions of interface with other materials, and flashing details at roof penetrations and roof drains.
- E. Manufacturer's Installation Instructions: Indicate membrane seaming precautions, special procedures, and perimeter conditions requiring special attention.

- F. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- G. Manufacturer's Field Reports: Indicate procedures followed, ambient temperatures, humidity, wind velocity during application, and supplementary instructions given.
- H. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 PRE-INSTALLATION MEETING

- A. General Contractor to schedule pre-installation meeting with Owner/Architect/GC/Roofing Contractor prior to any work being started on roof and after approved submittals.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's original containers, dry and undamaged, with seals and labels intact.
- B. Store materials in weather protected environment, clear of ground and moisture.
- C. Ensure storage and staging of materials does not exceed static and dynamic load-bearing capacities of roof decking.

1.07 QUALITY ASSURANCE

- A. Perform work in accordance with this specification section and manufacturer's instructions.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.
- C. Roof manufacturer shall approve insulation substrate prior to installation of substrate for roofing system specified without additional components.
- D. Upon completion of the installation, an inspection will be conducted by a technical representative of the roofing manufacturer to assure the membrane roofing system has been installed according to the roofing manufacturer's published specifications and details.
- E. Roofing system shall be approved by UL as a Class A system and achieve FM Class 1A/I-90 rating.

1.08 PROJECT CONDITIONS

1.09 ENVIRONMENTAL REQUIREMENTS

- A. Do not apply roofing membrane during unsuitable weather.
- B. Do not apply roofing membrane when ambient temperature is below 40 degrees F (5 degrees C) without taking special precautions with adhesives as recommended by the roofing manufacturer.
- C. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.
- D. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.

1.10 WARRANTY

- A. All work shall be accompanied by a qualified Roofing Contractor under the supervision in accordance with the membrane manufacturer. All work and modifications to the roofing systems including all flashings and insulation shall comply with the existing roofing membrane manufacturer warranty requirements as if the warranty is still in force.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Membrane Materials:

1. Carlisle SynTec Incorporated; Sure-Seal EPDM; www.carlisle-syntec.com.
2. Versico, Inc.
3. GenFlex Roofing Systems, LLC[]: www.genflex.com/#sle.
4. Substitutions: See Section 01 6000 - Product Requirements.

B. Insulation:

1. Carlisle SynTec Systems.
2. Atlas Roofing Corporation: www.atlasroofing.com.
3. GAF: www.gaf.com/#sle.
4. Substitutions: See Section 01 6000 - Product Requirements.

2.02 ROOFING - UNBALLASTED APPLICATIONS

- A. Elastomeric Sheet Membrane Roofing: 60 mil thick reinforced, white EPDM sheet membrane, same as Carlisle SynTec System's "Sure-Seal"
- B. Roofing Assembly Requirements:
 1. Roof Covering External Fire Resistance Classification: UL (DIR) certified Class A.
 2. Factory Mutual Classification: Class I and windstorm resistance of IA-90, in accordance with FM DS 1-28.
 3. Insulation Thermal Value (R), minimum: Provide insulation thickness required to match existing roof system insulation for patching.
- C. Acceptable Insulation Type - Constant Thickness Application: Polyisocyanurate that meets requirements and is approved by membrane manufacturer for application.
 1. Minimum 2 layers of polyisocyanurate board.
- D. Acceptable Insulation Types - Tapered Application: Polyisocyanurate that meets requirements and is approved by membrane manufacturer for application.
 1. Tapered polyisocyanurate, perlite, or extruded polystyrene board.
- E. Flexible Flashing Material: Same material as membrane; conforming to the following:
 1. Thickness: 0.060 inch (1.5 mm).
 2. Tensile Strength: 1,200 psi (8.3 MPa).
 3. Elasticity: 50 percent with full recovery without set.
 4. Color: Match roof membrane.
 5. Product: Sure-Seal Non Reinforced Cured EPDM Flashing manufactured by Carlisle SynTec System.
- F. Recovery Board: As recommended by manufacturer for roofing system; conforming to the following (manufacturer to verify).
 1. Thickness: minimum 0.50 inch.
 2. Weight: 1.1 lbs/ft².
 3. Surface: Glass mat.
 4. Permeance: 50 perms.
 5. R Value: .56.
 6. Compression Strength: 500 psi.
 7. Fire Classification: UL Class A.
 8. Fastening: Per manufacturer's instructions.
 9. Product: "Densdeck" manufactured by Carlisle Syntec Systems.

2.03 ACCESSORIES

- A. Seaming Materials: As recommended by Membrane Manufacturer.
- B. Stack Boots: Prefabricated flexible boot and collar for pipe stacks through membrane; same material as membrane.
- C. Insulation Fasteners: Appropriate for purpose intended.

1. Length as required for thickness of insulation material and penetration of deck substrate, with metal washers.
- D. Membrane Adhesive: As recommended by membrane manufacturer.
- E. Surface Conditioner for Adhesives: Compatible with membrane and adhesives.
- F. Thinners and Cleaners: As recommended by adhesive manufacturer, compatible with membrane.
- G. Sealants: As recommended by membrane manufacturer.
- H. Walkway Pads: White, molded rubber walkway pad with slip resistant surface and factory rounded corners, 30 x 30 x 3/8 inch.

2.04 INSULATION

- A. Poly-Isocyanurate Board Insulation: Rigid isocyanurate foam, ASTM C 1289-01, Class 1, Type II; faces finished with reinforced glass fiber, with the following characteristics:
 1. Board Size: 48 x 96 inch (1220 x 2440 mm).
 2. Board Thickness: Varies, 2 inch (50 mm) minimum. Reference drawings for thickness requirements.
 3. Board Edges: Square.
 4. Thermal Conductivity (k factor): 0.16 (0.27).
 5. Board Density: 1.8 lb/cu ft (29 kg/cu m).
 6. Manufacturers:
 - a. Carlisle SynTec Systems.
 - b. Apache Products Company.
 - c. Atlas Roofing Corporation.
 7. Substitutions: See Section 01600 - Product Requirements.
- B. Acceptable Insulation Type: Tapered Application: Polyisocyanurate that meets requirements and is approved by membrane manufacturer for application.
 1. Tapered Polyisocyanurate board.
- C. Accessories
 1. Insulation Joint Tape: Glass fiber reinforced type as recommended by insulation manufacturer, compatible with roofing materials; 6 inches (150 mm) wide; self adhering.
 2. Insulation Fasteners: Appropriate for purpose intended and approved by Factory Mutual and roofing manufacturer.
 - a. Length as required for thickness of insulation material and penetration of deck substrate, with metal washers.
 3. Insulation Adhesive (for use as concrete structure): As recommended by insulation manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces and site conditions are ready to receive work.
- B. Verify deck is supported and secure.
- C. Verify deck is clean and smooth, flat, free of depressions, waves, or projections, properly sloped and suitable for installation of roof system.
- D. Verify deck surfaces are dry and free of snow or ice.
- E. Verify that roof openings, curbs, and penetrations through roof are solidly set, and cant strips are in place.
- F. Do not start work until unsatisfactory conditions have been corrected.

3.02 INSULATION - UNDER MEMBRANE

- A. Attachment of Insulation (Metal Deck):
 - 1. Mechanically fasten insulation to deck in accordance with insulation manufacturer's instructions and Factory Mutual requirements.
- B. Lay subsequent layers of insulation with joints staggered minimum 6 inch (150 mm) from joints of preceding layer.
- C. Place tapered insulation to the required slope pattern in accordance with manufacturer's instructions.
- D. On metal deck, place boards perpendicular to flutes with insulation board ends bearing on deck flutes.
- E. Lay boards with edges in moderate contact without forcing. Cut insulation to fit neatly to perimeter blocking and around penetrations through roof.
- F. Tape joints of insulation in accordance with insulation manufacturer's instructions.
- G. At scupper drains, use factory-tapered boards to slope down to roof drains over a distance of 18 inches (450 mm).
- H. Do not apply more insulation than can be covered with membrane in same day.

3.03 INSTALLATION - MEMBRANE

- A. Roll out membrane, free from wrinkles or tears. Place sheet into place without stretching.
- B. Shingle joints on sloped substrate in direction of drainage.
- C. Fully Adhered Application: Fully embed membrane in adhesive except in areas directly over or within 3 inches (75 mm) of expansion joints. Fully adhere one roll before proceeding to adjacent rolls.
- D. Overlap edges and ends and seal seams by heat welding, minimum 3 inches (75 mm). Seal permanently waterproof. All seams shall be shingled in direction of drainage to avoid bucking of water.
- E. Penetrations: Cut holes to fit tightly around penetrations, flash with membrane, and apply color flashing. Where noted, provide pitch pockets filled with pourable sealer.
- F. Install walkway pads adhered fully to membrane with splicing cement.
- G. Flash and terminate roofing system in with manufacturer's printed specifications and details.
- H. Provide and install all required accessories and components for a complete, watertight installation.
- I. Coordinate with coping, counterflashing and other metal work in contact with roof membrane, to assure watertightness of roof system. Communicate all requirements for associated work to Contractor and related trades so that warranty can be provided without any exclusions.
- J. Around roof penetrations, seal flanges and flashings with flexible flashing.
- K. Coordinate installation of scuppers and sumps and related flashings.

3.04 PLACEMENT OF WALKWAY PADS/ROLLS

- A. Prep and adhere walkway pads to membrane roofing per manufacturer's recommendations.
- B. Place walkway pads from all roof access points to mechanical equipment as well as a direct route to walkway rolls at perimeter of metal roof system. Reference drawings for locations.
- C. Place walkway rolls continuous, except as dictated by roof membrane manufacturer, at the perimeter of metal roof system for protection of roof membrane.

3.05 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements for additional requirements.
- B. Arrange for approved manufacturer's representative to inspect base surface prior to installation, during installation, and after completed installation to assure conformance with manufacturer's specifications.
- C. Test roofing for watertightness.

3.06 CLEANING

- A. Remove bituminous markings from finished surfaces.
- B. In areas where finished surfaces are soiled by work of this section, consult manufacturer of surfaces for cleaning advice and comply with their documented instructions.
- C. Repair or replace defaced or damaged finishes caused by work of this section.

3.07 PROTECTION

- A. Protect installed roofing and flashings from construction operations.
- B. Provide temporary protection to prevent damage to roofing membrane by work of other Sections after installation of membrane and until final acceptance of the project by the Owner.

END OF SECTION 07 5300

SECTION 07 6200
SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fabricated sheet metal items including:
 - 1. Flashings
 - 2. Counterflashings
 - 3. Metal cap at roof curb.
 - 4. Other items indicated on Contract Documents.
- B. Sealants for joints within sheet metal fabrications.

1.02 RELATED REQUIREMENTS

- A. Section 06 1000 - Rough Carpentry: Wood blocking roofing substrate profiles.
- B. Section 07 5300 - Elastomeric Roofing: For installing integral flashing and counterflashing.
- C. Section 07 9200 - Joint Sealants: Sealing non-lap joints between sheet metal fabrications and adjacent construction.

1.03 REFERENCE STANDARDS

- A. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2013.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.
- C. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2015.
- D. ASTM B32 - Standard Specification for Solder Metal; 2008 (Reapproved 2014).
- E. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.
- F. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric); 2014.
- G. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2014a.
- H. CDA A4050 - Copper in Architecture - Handbook; current edition.
- I. SMACNA (ASMM) - Architectural Sheet Metal Manual; 2012.

1.04 SUBMITTALS

- A. See Special Conditions, Submittals for submittal procedures.
- B. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.
- C. Samples: Submit two samples 3 x 3 inch (76 x 76 mm) in size illustrating metal finish color.

1.05 QUALITY ASSURANCE

- A. Perform work in accordance with SMACNA (ASMM) and CDA A4050 requirements and standard details, except as otherwise indicated.
- B. Fabricator and Installer Qualifications: Company specializing in sheet metal work with three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

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

1.07 PROJECT CONDITIONS

- A. Coordinate with the work of Section 07 5300 - Elastomeric Membrane Roofing for installing integral flashing and counter flashing.

PART 2 PRODUCTS

2.01 SHEET MATERIALS

- A. Galvanized Steel: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 24 gage (0.0239 inch) (0.61 mm) thick base metal.
- B. Pre-Finished Galvanized Steel: ASTM A 653/A 653M, with G90/Z275 zinc coating; minimum .035 inch (.89 mm) thick base metal, shop pre-coated with PVDF coating of color as selected to match existing metal wall system.

2.02 ACCESSORIES

- A. Fasteners: Stainless steel, with soft neoprene washers where required.
- B. Sealant to be Concealed in Completed Work: Non-curing butyl sealant.
- C. Sealant to be Exposed in Completed Work: ASTM C920; elastomeric sealant, 100 percent silicone with minimum movement capability of plus/minus 25 percent and recommended by manufacturer for substrates to be sealed; clear.
- D. Flashing Compound: Polyisobutylene type, nonskinning, nondrying sealant, bulk or tape as required by installation conditions. Tape shall be one inch minimum width, 1/16 inch minimum thickness. Same as Presstite Products Inmont Corp.'s "Permagum 579.65 and 579.64"; Dap, Inc.'s "DAP Butyl Gutter and Lap Sealer"; Cushion-Lok Div. of Morrison and Co.'s "CL-50"; Hapco Products' No. 600; or approved equal.
- E. Items for Permanent Protection of Dissimilar Metals and Materials:
 - 1. Asphalt-Saturated Felt: ASTM D226.
 - 2. Bituminous Paint: Fed. Spec. TT-C-494A.
 - 3. Compressible Tape: ASTM C509. Closed cell black neoprene tape, size as noted, with adhesive system as recommended by manufacturer.
 - 4. Self Healing modified bitumen sheet or tape.

2.03 FABRICATION

- A. Preparation: Verify measurements in field and coordinate with related work as required for proper and adequate fabrication and installation.
- B. General Requirements:
 - 1. Items of standard manufacturer may be furnished in lieu of specially fabricated items provided such items meet requirements and profiles shown or noted.
 - 2. As far as practicable, form and fabricate sheet metal items in shop. Where circumstances require on-site fabrication, provide quality equal to shop work.
 - 3. Accurately reproduce profiles and bends as shown or noted. Ensure that intersections are sharp, even, and true; that plane surfaces are free from buckles and waves; that seams follow direction of water flow.
 - 4. Where work is not otherwise shown or noted, design and fabricate in accordance with SMACNA.
 - 5. Reinforce properly as required for strength and appearance.

6. Cut, fit, and drill sheet metal as required to accommodate accessory items and work adjacent or adjoining.
 7. Exposed Edges of Sheet Metal: Fold, bead, or return; no raw edges will be permitted.
- C. Sheet Metal Joints:
1. In general and unless detailed otherwise, provide lock joints; where impracticable, lap, rivet, and solder.
 2. Turn lock joints on exposed surfaces in direction of flow.
 3. Solder joints and miters.
 4. Where positive joining is required, arc-weld in accordance with AWS D1.1, AWS D1.3, or braze.
- D. Soldering:
1. Pre-tin edges 1-1/2 inch both sides prior to soldering.
 2. Use heavy soldering coppers of blunt design.
 3. Immediately after applying flux, solder slowly with well-heated coppers, thoroughly heating seams and completely sweating solder through full width with at least one inch width along seams.
 4. After soldering, immediately neutralize any acid flux and finish with clean water.
- E. Expansion-Contraction of Sheet Metal Runs: Provide loose locking slip joint at maximum eight feet from external or internal corners, at every 24 feet of straight runs unless SMACNA recommends more frequent interval, and one at center of runs less than 20 feet but more than eight feet long.
- F. Flashing and Counterflashing:
1. Fabricate runs in maximum lengths subject to expansion-contraction allowance with minimum number of joints.
 2. Form counterflashings to lock rigidly into reglets where required.
 3. Exposed Edges: Turn back and hem 1/2 inch.

2.04 FINISHES

- A. Sheet Metal: Manufacturer's standard finish unless otherwise noted.
1. Galvanized Sheet Steel: After fabrication, touch-up abraded surfaces.
- B. Permanent Protection of Dissimilar Metals and Materials:
1. Items in Contact with Dissimilar Metals: Protect as required to prevent corrosion and discoloration from galvanic action.
 2. Items in Contact with Concrete, Masonry Mortar, or Plaster or Not Accessible After Installation: Underlay items with asphalt-saturated felt or apply heavy coating of bituminous paint at areas of contact.
 3. Items in Contact with Moisture Absorbent Materials or Preservative-Treated Wood: Apply heavy coating of bituminous paint at areas of contact.
 4. Fasteners and Anchors of Materials Dissimilar from Items Fastened: Mask as required to prevent corrosion and discoloration from galvanic action.

PART 3 EXECUTION

3.01 INSPECTION

- A. Examine areas to receive items and verify following:
1. That dimensions are correct to receive items.
 2. That adjacent or adjoining surfaces are clean, dry, reasonably smooth, and free from defects; that wood surfaces to be in contact with sheet metal are free from projecting nails.
 3. Absence of other conditions that will adversely affect installation.
- B. Do not start work until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Coordinate as required with installation of related work.
- B. Where flashing and sheet metal work is related to elastomeric roofing, coordinate installation with roofing applicator.
- C. Where flashing and masonry work is related, coordinate installation with mason.

3.03 INSTALLATION

- A. General Requirements:
 - 1. Install items in accordance with SMACNA unless otherwise noted.
 - 2. Where installation required performing work of fabrication, meet requirements of applicable standards of Fabrication Article.
 - 3. Apply flashing compound at slip joints or wherever else metal-to-metal contact occurs and movement may be anticipated.
 - 4. Unless otherwise noted or required by manufacturer, fasten sheet metal runs to underlying material by nailing through slotted holes in flange at three inches on center. Provide waterproof washers wherever required fasteners penetrate flashings. Where sheet metal occurs over roofing materials or other sheet metal, use nails with one inch metal disks.
 - 5. Insure that items are installed in true and accurate alignment with other items and related work; that joints are accurately fitted; that exposed surfaces are free from dents; that corners are reinforced; that seams are watertight.

3.04 FIELD QUALITY CONTROL

- A. See Special Conditions, for field inspection requirements.
- B. Inspection will involve surveillance of work during installation to ascertain compliance with specified requirements.

3.05 SCHEDULE

- A. Counterflashings at Roofing Terminations (over roofing base flashings):
 - 1. Material: Galvanized Steel.
- B. Counterflashings at Curb-Mounted Roof Items, including roof hatches:
 - 1. Material: Galvanized Steel.
- C. Counterflashings at Roofing Penetration for Pipes, Structural Steel, and Equipment Supports:
 - 1. Material: Galvanized Steel.

END OF SECTION 07 6200

**SECTION 07 8400
FIRESTOPPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Firestopping materials.
- B. Firestopping and related accessories at all penetrations and interruptions to fire rated assemblies as follows:
 - 1. Penetrations for the passage of duct, cable, cable tray, conduit, piping, electrical busways and raceways through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor/ceiling assemblies), and vertical service shaft walls and partitions.
 - 2. Safing slot gaps between edge of floor slabs and curtain walls.
 - 3. Openings between structurally separate sections of walls or floors.
 - 4. Gaps between the top of walls and ceiling or roof assemblies.
 - 5. Expansion joints in walls and floors.
 - 6. Openings and penetrations in fire-rated partitions or walls containing fire doors.
 - 7. Openings around structural members which penetrate floor or walls.
- C. DEFINITIONS
 - 1. Firestopping: Material or combination of materials used to retain integrity of fire-rated construction by maintaining an effective barrier against the spread of flame, smoke, and hot gasses through penetrations in fire-rated wall and floor assemblies.

1.02 RELATED REQUIREMENTS

- A. Section 01 1045 - Cutting and Patching.
- B. Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- C. Section 03 3000 - Cast-in-Place Concrete.
- D. Section 07 2100 - Thermal Insulation: Firesafing Insulation.
- E. Section 07 9200 - Joint Sealants.
- F. Section 09 2116 - Gypsum Board Assemblies: Gypsum wallboard fireproofing.
- G. Section 22 0000 - Supplementary Plumbing General Conditions.
- H. Section 23 0000 - Supplementary Mechanical General Conditions.
- I. Section 26 0000 - Supplementary Electrical General Conditions.

1.03 REFERENCE STANDARDS

- A. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2015.
- B. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2013a.
- C. ITS (DIR) - Directory of Listed Products; Current Edition.
- D. 11
- E. SCAQMD 1168 - South Coast Air Quality Management District Rule No.1168; current edition; www.aqmd.gov.
- F. UL (FRD) - Fire Resistance Directory; Current Edition.
 - 1. UL Fire Resistance Directory:
 - a. Through penetration Firestop Devices (XHJI).
 - b. Fire Resistance Rating (BXUV).
 - c. Through-Penetration Firestop Systems (XHEZ).
 - d. Fills, Voids, or Cavity Materials (XHHW).

- e. Forming Materials (XHKU).

1.04 SUBMITTALS

- A. See Special Conditions - Submittals, for submittal procedures.
- B. Schedule of Firestopping: List each type of penetration, fire rating of the penetrated assembly, and firestopping test or design number.
- C. Product Data: Provide data on product characteristics, performance ratings, and limitations.
- D. Sustainable Design Submittal: Submit VOC content documentation for all non-preformed materials.
- E. Manufacturer's Installation Instructions: Indicate preparation and installation instructions.
- F. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- G. Certificates: Upon completion of work, furnish written statement signed by the Contractor, applicator, and manufacturer stating firestopping application complies with drawings, specifications, and manufacturer's recommendations and was proper and adequate for conditions requiring firestopping.
- H. Certificate from authority having jurisdiction indicating approval of materials used.

1.05 QUALITY ASSURANCE

- A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.
 - 1. Listing in UL (FRD), 1, or ITS (DIR) will be considered as constituting an acceptable test report.
 - 2. Current evaluation reports published by CABO, ICBO, or IBC will be considered as constituting an acceptable test report.
 - 3. For those firestop applications that exist for which no UL tested system is available through any manufacturer, a manufacturer's engineering judgement derived from similar UL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Installer Qualifications: Company specializing in performing the work of this section with a minimum 3 years documented experience and approved by firestopping manufacturer.

1.06 JOB CONDITIONS

- A. Environmental Requirements: Apply materials only when surface and ambient temperatures fall within manufacturer-recommended ranges and ventilation and safety requirements are in accordance with manufacturer.
- B. Protection:
 - 1. Use masking tape where required to control lap of materials on adjacent surfaces and remove upon completion.
 - 2. Be responsible for damage to adjacent surfaces caused by firestopping operations.
 - 3. Protect firestopping as necessary against damage from other construction activities.
- C. Scheduling, Sequencing: Schedule application only after concrete has cured and joints and openings are most likely to be normal size.

1.07 FIELD CONDITIONS

- A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation; maintain minimum temperature before, during, and for three days after installation of materials.

- B. Provide ventilation in areas where solvent-cured materials are being installed.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Manufacturers:
1. 3M Fire Protection Products: www.3m.com/firestop.
 2. Hilti, Inc: www.us.hilti.com/#sle.
 3. Specified Technologies, Inc.: www.stifirestop.com.
 4. Substitutions: See Section 01 2500 - Substitutions.
- B. Volatile Organic Compound (VOC) Content: Provide products having VOC content lower than that required by 1.
- C. Mold and Mildew Resistance: Provide firestopping materials with mold and mildew resistance rating of zero(0) in accordance with ASTM G21.
- D. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Provide type of materials as required for tested firestopping assembly.
- E. Fire Ratings: Refer to drawings for required systems and ratings.

2.02 FIRESTOPPING ASSEMBLIES

- A. General Requirements:
1. Firestopping shall be by one manufacturer. Manufacturer shall have complete UL approved system of sealants and other penetration firestopping products to provide proper firestopping of penetrations.
 2. Firestopping shall be compatible with contacting material.
 3. Firestopping shall not stain adjacent exposed surfaces.
 4. Firestopping material shall be free of asbestos.
 5. Firestopping material shall provide flame and temperature rating as noted for assembly being penetrated as tested in accordance with ASTM E814-2000.
 6. Firestopping products that are water soluble or subject to cracking or breakage when exposed to moisture or vibration shall not be used.
- B. Acceptable materials for penetrations by non-combustible items including steel pipe, copper pipe, rigid steel conduit and electrical metallic tubing (EMT):
1. IPC FS900 Sealant.
 2. 3M Fire Stop Sealant 2000.
 3. 3M Fire Barrier CP25 WB+.
 4. Nelson CLK Firestop Sealant.
 5. STI SpecSeal SSS100 Sealant.
 6. STI PEN 300 Silicone Sealant.
 7. Hilti FS-One Intumescent Sealant.
- C. Acceptable for fire-rated construction joints and other gaps:
1. 3M Firestop Sealant 2000.
 2. STI PEN 300 Silicone Joint Sealant.
 3. Hilti CP 6015 Elastomeric Firestop Sealant.
- D. Acceptable for penetrations by combustible items including insulated metal pipe, PVC jacketed, flexible cable or cable bundles other than data and communication and plastic pipe (closed piping systems):
1. 3M Fire Barrier CP25 WB+.
 2. 3M Fire Barrier FS-195 Wrap/Strip.
 3. Nelson FSP Intumescent Firestop Sealant.
 4. STI SpecSeal SSS100 Sealant.

5. STI SpecSeal SSWRED Wrapstrip.
 6. Hilti CP 645 Firestop Wrap Strip.
- E. Acceptable for penetrations by combustible plastic pipe (open piping systems):
1. 3M Fire Barrier PPD Plastic Pipe Device.
 2. Nelson PCS Prefabricated Device.
 3. STI SpecSeal SSC Collars.
 4. Hilti CP 642/CP 643 Firestop Collar.
- F. Acceptable for large/complex penetrations made to accommodate cable trays, multiple steel and copper pipe, electrical busways in raceways:
1. 3M Fire Stop Foam 2001.
 2. 3M Fire Barrier CS-195 Composite Sheet.
 3. Nelson CMP Firestop Compound.
 4. Nelson PLW Firestop Pillows.
 5. STI SpecSeal SSM Firestop Compound.
 6. STI SpecSeal SSB Firestop Pillows.
 7. Hilti CP 637 Firestop Mortar.
- G. Acceptable for openings between structurally separate sections of walls and floors:
1. 3M Fire Stop Sealant 2000.
 2. STI PEN 300 Silicone Joint Sealant.
 3. Hilti CP 672 Speed Spray.
- H. Firestopping: System, seal apparatus, collar, bag or other firestopping components as may be needed to provide UL approved firestopping for specific penetration condition.
- I. Tops of partitions:
1. Same as Hilti System CP767 and CP777 Speed Strips and Speed Plugs with Hilti CP672 Speedspray conforming to U.L. Design No. HW-D-0044.
- J. Vault Wall Cavity Closure to Existing Structure:
1. Provide 4" thick mineral wool Type 5 insulation as specified in Section 07 2100 with elastomeric firestopping firm sprayed over. Same as 3M Fire Dam Spray 100 conforming to UL Design No. CEJ116P.
- K. Firestopping System for data and communication cabling and cable bundles:
1. Specified Technologies, Inc. EZ Path Fire Rated Pathway. Pathway to be used at all rated wall and floor assemblies for Data and Communications cabling, including all Data/Comm Room floor penetrations for required rated constructed. Provide number as required to coordinate with data and communication cabling equivalent to sleeve sizes and quantities shown on electrical drawings. Provide 2 additional EZ pathway units for future cabling adjacent to installed cable bundle EZ path units.

2.03 MATERIALS

- A. Accessories:
1. Primers, Sealers, Surface Conditioners, Solvents: As recommended by manufacturer of approved firestopping material for each substrate. Solvents shall be residue-free.
 2. Typical Back-Up Material: As recommended by firestopping manufacturer.

PART 3 EXECUTION

3.01 INSPECTION

- A. Inspect joints and spaces to receive firestopping and verify following:
1. That surfaces are satisfactory for proper installation of firestopping.
 2. That sprayed fireproofing work has been completed and cured properly.
- B. Do not start application until unsatisfactory conditions have been corrected.

3.02 EXAMINATION

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

3.03 PREPARATION

- A. Cleaning:
 - 1. Thoroughly clean receiving surfaces, joints, and spaces of foreign material such as dirt, dust, mill-scale, rust, oil, grease, sealer, curing compound, paint, and other coatings.
 - 2. Blow joints free of loose particles.
 - 3. Use only cleaning materials approved by firestopping manufacturer.
- B. Verify proper surface and ambient temperatures.
- C. Mask where necessary to protect adjoining surfaces. Remove excess material and stains on surfaces as required.
- D. Primers, If Required:
 - 1. Make preliminary tests to insure primers will not stain exposed materials or deteriorate back-up material.
 - 2. Prime surfaces as recommended by firestopping manufacturer immediately prior to sealing.
- E. In all other respects, prepare surfaces in accordance with manufacturer's recommendations.

3.04 APPLICATION

- A. General Requirements:
 - 1. Apply in exact accordance with manufacturer's specifications to provide fire rating of assembly being penetrated.
 - 2. Use only skilled mechanics on work.
 - 3. Install firestopping with sufficient pressure to properly fill and seal openings.
- B. Firestopping:
 - 1. Surface Depth: Provide full depth and width of spaces around penetration, and on each side of wall or partition construction for a depth not less than the thickness of the wall or partition finish materials.
 - 2. Tooling:
 - a. Using tooling agent recommended by firestopping manufacturer, neatly tool joints to compress material, improve adhesion to surfaces joined, and achieve slightly concave surface.
 - b. Repair air pockets exposed by tooling.
 - c. Use masking tape where required to facilitate tooling and remove upon completion.

3.05 FIELD QUALITY CONTROL

- A. Manufacturer's Representative: Conduct periodic inspections to ensure adherence to previously approved procedures.

3.06 PATCHING

- A. Patch or replace defective and damaged firestopping as directed by the Architect.

3.07 CLEANING

- A. Clean adjacent surfaces soiled in applying firestopping in accordance with firestopping manufacturer's recommendation.
- B. Remove spilled and excess materials from adjacent surfaces before it has set.
- C. Remove all debris and excess materials entirely from site and leave work in a neat and tidy condition.

END OF SECTION 07 8400

**SECTION 07 9200
JOINT SEALANTS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Nonsag gunnable joint sealants.
- B. Self-leveling pourable joint sealants.
- C. Joint backings and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions: Additional requirements for sealants and primers.
- B. Section 07 8400 - Firestopping: Firestopping sealants.
- C. Section 08 8000 - Glazing: Glazing sealants and accessories.
- D. Section 09 2116 - Gypsum Board Assemblies: Sealing acoustical and sound-rated walls and ceilings.
- E. Section 09 2216 - Non-Structural Metal Framing: Sealing between framing and adjacent construction in acoustical and sound-rated walls and ceilings.
- F. Section 23 3100 - HVAC Ducts and Casings: Duct sealants.

1.03 REFERENCE STANDARDS

- A. ASTM C661 - Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer; 2015 (Reapproved 2022).
- B. ASTM C794 - Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants; 2018 (Reapproved 2022).
- C. ASTM C834 - Standard Specification for Latex Sealants; 2010.
- D. ASTM C919 - Standard Practice for Use of Sealants in Acoustical Applications; 2022.
- E. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018.
- F. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2016.
- G. ASTM C1248 - Standard Test Method for Staining of Porous Substrate by Joint Sealants; 2022.
- H. ASTM C1330 - Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants; 2002 (Reapproved 2013).
- I. ASTM C1521 - Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints; 2019 (Reapproved 2020).
- J. ASTM D2240 - Standard Test Method for Rubber Property--Durometer Hardness; 2015 (Reapproved 2021).
- K. SWRI (VAL) - SWR Institute Validated Products Directory; Current Edition.

1.04 SUBMITTALS

- A. See Special Conditions - Submittals, for submittal procedures.
- B. Product Data for Sealants: Submit manufacturer's technical data sheets for each product to be used, that includes the following.
 - 1. Physical characteristics, including movement capability, VOC content, hardness, cure time, and color availability.
 - 2. List of backing materials approved for use with the specific product.
 - 3.

4. Substrates that product is known to satisfactorily adhere to and with which it is compatible.
 5. Substrates the product should not be used on.
 6. Substrates for which use of primer is required.
 7. Substrates for which laboratory adhesion and/or compatibility testing is required.
 8. Installation instructions, including precautions, limitations, and recommended backing materials and tools.
 9. Sample product warranty.
 10. Certification by manufacturer indicating that product complies with specification requirements.
 11. SWRI Validation: Provide currently available sealant product validations as listed by SWRI (VAL) for specified sealants.
- C. Product Data for Accessory Products: Submit manufacturer's technical data sheet for each product to be used, including physical characteristics, installation instructions, and recommended tools.
- D. Color Samples for Selection: Where sealant color is not specified, submit manufacturer's actual sealant sample cards showing standard colors available for selection.
- E. Samples for Verification: Where sealant color is not specified, obtain directions from Architect and submit at least two physical samples for verification of color of each required sealant.
- F. Preinstallation Field Adhesion Test Reports: Submit filled out Preinstallation Field Adhesion Test Reports log within 10 days after completion of tests; include bagged test samples and photographic records.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum ten years documented experience.
- B. Preinstallation Field Adhesion Test Plan: Include destructive field adhesion testing of one sample of each combination of sealant type and substrate, except interior acrylic latex sealants, and include the following for each tested sample.
1. Identification of testing agency.
 2. Preinstallation Field Adhesion Test Log Form: Include the following data fields, with known information filled out.
 - a. Test date.
 - b. Copy of test method documents.
 - c. Age of sealant upon date of testing.
 - d. Test results, modeled after the sample form in the test method document.
 - e. Indicate use of photographic record of test.
- C. Field Adhesion Test Procedures:
1. Allow sealants to fully cure as recommended by manufacturer before testing.
 2. Have a copy of the test method document available during tests.
 3. Record the type of failure that occurred, other information required by test method, and the information required on the Field Quality Control Log.
 4. If any combination of sealant type and substrate does not show evidence of minimum adhesion or shows cohesion failure before minimum adhesion, report results to Architect.

1.06 WARRANTY

- A. Correct defective work within a five year period after Date of Substantial Completion.
- B. Warranty: Include coverage for installed sealants and accessories that fail to achieve watertight seal, exhibit loss of adhesion or cohesion, or do not cure.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Nonsag Sealants:
1. Dow Corning Corporation: www.dowcorning.com/construction/#sle.
 2. Momentive Performance Materials, Inc (formerly GE Silicones): www.momentive.com.
 3. Pecora Corporation: www.pecora.com.
 4. Tremco Global Sealants: www.tremcosealants.com.
 5. Substitutions: See Section 01 2500 - Substitutions.

2.02

- A. Scope:
1. Exterior Joints: Seal open joints, whether or not the joint is indicated on drawings, unless specifically indicated not to be sealed. Exterior joints to be sealed include, but are not limited to, the following items.
 - a. Joints between door, window, and other frames and adjacent construction.
 - b. Joints between different exposed materials.
 - c. Other joints indicated below.
 2. Interior Joints: Interior joints to be sealed include, but are not limited to, the following items.
 - a. Joints between door, window, and other frames and adjacent construction.
 - b. In sound-rated wall and ceiling assemblies, gaps at electrical outlets, wiring devices, piping, and other openings; between wall/ceiling and other construction; and other flanking sound paths.
 - 1) Exception: Through-penetrations in sound-rated assemblies that are also fire-rated assemblies.
 - c. At junction of plumbing fixtures and adjacent wall / floor surfaces.
 - d. At junction of plastic laminate component and wall surface, i.e. splashes, wall cabinets, solid polymer countertop and splashes.
 - e. Other joints indicated below.
 3.
 - a. Intentional weep holes in masonry.
 - b.
 - c.
 - d.
 - e.
- B. Exterior Joints: Use nonsag non-staining silicone sealant, Type 1, unless otherwise indicated.
 1. Type 5 - Lap Joints in Sheet Metal Fabrications: Butyl rubber, noncuring.
 2. Control and expansion joints in brick masonry: .
- C. Interior Joints: Use non-sag acrylic-urethane sealant, Type 4, unless otherwise indicated.
 1. Wall and Ceiling Joints in Non-Wet Areas: Type 4.
 2. Type 2 - Joints between Fixtures in Wet Areas and Floors, Walls, and Ceilings: Mildew-resistant silicone sealant; white.
- D. Interior Wet Areas: Bathrooms and restrooms; fixtures in wet areas include plumbing fixtures, countertops, cabinets, and other similar items.

2.03 JOINT SEALANTS - GENERAL

- A. Sealants and Primers: Provide products with acceptable levels of volatile organic compound (VOC) content; see Section 01 6116.
- B. Colors: As selected by Architect.

2.04 NONSAG JOINT SEALANTS

- A. Type 1 - Non-Staining Silicone Sealant: ASTM C920, Grade NS, Uses M and A; not expected to withstand continuous water immersion or traffic.
1. Movement Capability: Plus 100 percent, minus 50 percent, minimum.
 2. Non-Staining To Porous Stone: Non-staining to light-colored natural stone or marble when tested in accordance with ASTM C1248.
 3. Dirt Pick-Up: Reduced dirt pick-up compared to other silicone sealants.
 4. Hardness Range: 15 to 35, Shore A, when tested in accordance with ASTM C661.
 5. Color: To be selected by Architect from manufacturer's standard range.
 6. Service Temperature Range: Minus 65 to 180 degrees F (Minus 54 to 82 degrees C).
 7. Products:
 - a. Dow Corning Corporation; "790 Silicone Building Sealant": www.dowcorning.com/construction/#sle.
 - b. Pecora Corporation; "890 NST Ultra Low Modulus Architectural Silicone Sealant - Class 100": www.pecora.com.
 - c. Substitutions: See Section 01 2500 - Substitutions.
- B. Type 2 - Mildew-Resistant Silicone Sealant: ASTM C920, Grade NS, Uses M and A; single component, mildew resistant; not expected to withstand continuous water immersion or traffic.
1. Color: White.
 2. Products:
 - a. Pecora Corporation; "898 NST Sanitary Silicone Sealant - Class 50": www.pecora.com.
 - b. Sika Corporation; "Sikasil GP": www.usa-sika.com/#sle.
 - c. Substitutions: See Section 01 2500 - Substitutions.
- C. Type 3 - Polyurethane Sealant: ASTM C920, Grade NS, Uses M and A; single or multicomponent; not expected to withstand continuous water immersion or traffic.
1. Movement Capability: Plus and minus 25 percent, minimum.
 2. Hardness Range: 20 to 35, Shore A, when tested in accordance with ASTM C661.
 3. Color: To be selected by Architect from manufacturer's standard range.
 4. Service Temperature Range: Minus 40 to 180 degrees F (Minus 40 to 82 degrees C).
 5. Products:
 - a. Pecora Corporation; "Dyna Trol I-XL": www.pecora.com.
 - b. Sika Corporation; "Sikaflex-2c NS": www.usa-sika.com/#sle.
 - c. Substitutions: See Section 01 6000 - Product Requirements.
- D. Type 4 - Acrylic-Urethane Sealant: Water-based; ASTM C920, Grade NS, Uses M and A; single component; paintable; not expected to withstand continuous water immersion or traffic.
1. Movement Capability: Plus and minus 12-1/2 percent Plus and minus 25 percent, minimum.
 2. Hardness Range: 20 to 40, Shore A, when tested in accordance with ASTM C661.
 3. Color: White.
 4. Service Temperature Range: Minus 40 to 180 degrees F (Minus 40 to 82 degrees C).
 5. Products:
 - a. Franklin International, Inc; Titebond UA 920 Sealant: www.titebond.com/#sle.
 - b. Sherwin-Williams Company; Shermax Urethanized Elastomeric Sealant: www.sherwin-williams.com/#sle.
 - c. Substitutions: See Section 01 6000 - Product Requirements.
- E.

2.05 ACCESSORIES

- A. Backer Rod: Cylindrical cellular foam rod with surface that sealant will not adhere to, compatible with specific sealant used, and recommended by backing and sealant manufacturers for specific application.
 - 1. Type for Joints Not Subject to Pedestrian or Vehicular Traffic: 1; Type C - Closed Cell Polyethylene.
 - 2. Closed Cell and Bi-Cellular: 30-50 percent larger in diameter than joint width.
- B. Backing Tape: Self-adhesive polyethylene tape with surface that sealant will not adhere to and recommended by tape and sealant manufacturers for specific application.
- C. Masking Tape: Self-adhesive, nonabsorbent, non-staining, removable without adhesive residue, and compatible with surfaces adjacent to joints and sealants.
- D. Joint Cleaner: Non-corrosive and non-staining type, type recommended by sealant manufacturer; compatible with joint forming materials.
- E. Primers: Type recommended by sealant manufacturer to suit application; non-staining.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that joints are ready to receive work.
- B. Verify that backing materials are compatible with sealants.
- C. Verify that backer rods are of the correct size.
- D. Preinstallation Adhesion Testing: Install a sample for each test location indicated in the test plan.
 - 1. Test each sample as specified in PART 1 under QUALITY ASSURANCE article.
 - 2. Notify Architect of date and time that tests will be performed, at least seven days in advance.
 - 3. Record each test on Preinstallation Adhesion Test Log as indicated.
 - 4. If any sample fails, review products and installation procedures, consult manufacturer, or take other measures that are necessary to ensure adhesion; retest in a different location; if unable to obtain satisfactory adhesion, report to Architect.
 - 5. After completion of tests, remove remaining sample material and prepare joints for new sealant installation.

3.02 PREPARATION

- A. Remove loose materials and foreign matter that could impair adhesion of sealant.
- B. Clean joints, and prime as necessary, in accordance with manufacturer's instructions.
- C. Perform preparation in accordance with manufacturer's instructions and 1.
- D. Mask elements and surfaces adjacent to joints from damage and disfigurement due to sealant work; be aware that sealant drips and smears may not be completely removable.
- E. Concrete Floor Joints That Will Be Exposed in Completed Work: Test joint filler in inconspicuous area to verify that it does not stain or discolor slab.

3.03 INSTALLATION

- A. Install this work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
- B. Provide joint sealant installations complying with 1.
- C. Measure joint dimensions and size joint backers to achieve the following:
 - 1. Width/depth ratio of 2:1.

2. Neck dimension no greater than 1/3 of the joint width.
 3. Surface bond area on each side not less than 75 percent of joint width.
- D. Install bond breaker backing tape where backer rod cannot be used.
 - E. Install sealant free of air pockets, foreign embedded matter, ridges, and sags, and without getting sealant on adjacent surfaces.
 - F. Do not install sealant when ambient temperature is outside manufacturer's recommended temperature range, or will be outside that range during the entire curing period, unless manufacturer's approval is obtained and instructions are followed.
 - G. Nonsag Sealants: Tool surface concave, unless otherwise indicated; remove masking tape immediately after tooling sealant surface.

3.04 POST-OCCUPANCY

- A. Post-Occupancy Inspection: Perform visual inspection of entire length of project sealant joints at a time that joints have opened to their greatest width; i.e. at low temperature in thermal cycle. Report failures immediately and repair.

END OF SECTION 07 9200

SECTION 08 1113
HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Hollow metal frames for wood doors.
- B. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 08 1416 - Flush Wood Doors: Wood doors installed in steel frames.
- B. Section 08 7100 - Door Hardware.
- C. Section 08 8000 - Glazing: Glass for doors and borrowed lites.
- D. Section 09 9123 - Interior Painting: Field painting.

1.03 ABBREVIATIONS AND ACRONYMS

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

1.04 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- B. ANSI/SDI A250.3 - Test Procedure and Acceptance Criteria for Factory Applied Finish Coatings for Steel Doors and Frames; 2019.
- C. ANSI/SDI A250.8 - Specifications for Standard Steel Doors and Frames (SDI-100); 2014.
- D. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames; 2020.
- E. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.
- F. ASTM A1008/A1008M - 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; 2015.
- G. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2014.
- H. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2009 (Reapproved 2016).
- I. BHMA A156.115 - American National Standard for Hardware Preparation in Steel Doors and Steel Frames; 2014 (ANSI/BHMA A156.115).
- J. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.
- K. DHI A115 Series - Specifications for Steel Doors and Frame Preparation for Hardware; Door and Hardware Institute; current edition (ANSI/DHI A115 Series).
- L. NAAMM HMMA 830 - Hardware Selection for Hollow Metal Doors and Frames; 2002.

- M. NAAMM HMMA 831 - Hardware Locations for Hollow Metal Doors and Frames; 2011.
- N. NAAMM HMMA 840 - Guide Specifications For Receipt, Storage and Installation of Hollow Metal Doors and Frames; 2017.
- O. NAAMM HMMA 850 - Fire-Rated Hollow Metal Doors and Frames; 2014.
- P. NAAMM HMMA 861 - Guide Specifications for Commercial Hollow Metal Doors and Frames; 2014.
- Q. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2022.
- R. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; 2022.
- S. 11
- T. UL 10B - Standard for Fire Tests of Door Assemblies; Current Edition, Including All Revisions.
- U. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies; Current Edition, Including All Revisions.

1.05 SUBMITTALS

- A. See Special Conditions - Submittals for submittal procedures.
- B. Product Data: Materials and details of design and construction, including core, edge and closure conditions, hardware locations, reinforcement type and locations, anchorage types, spacings and fastening methods, and finishes.
- C. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, fire resistive ratings, location of cutouts for hardware, and different finishes, if any. As required, include conduit and preparation for power, signal, and control system hardware support.
- D. Installation Instructions: Manufacturer's published instructions, including any special installation instructions relating to this project.
- E. Manufacturer's Certificate: Certification that products meet or exceed specified requirements.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of SDI 100 and ANSI A117.1.
- B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Accept doors and frames onsite in manufacturers original packaging. Do not use nonvented or plastic shelters.
- B. Inspect doors and frames on delivery for damages.
- C. Comply with NAAMM HMMA 840 or 1 (SDI-100) in accordance with specified requirements.
- D. Avoid humidity build-up under coverings; prevent corrosion.

1.08 PROJECT CONDITIONS

- A. Coordinate frame installation with size, surrounding door opening construction, location, and installation of service utilities.
- B. Coordinate frame and door installation with associated hardware.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Hollow Metal Frames:
 - 1. Ceco Door, an Assa Abloy Group company: www.assaabloydss.com.
 - 2. Republic Doors: www.republicdoor.com.

3. Steelcraft, an Allegion brand: www.allegion.com/sle.
4. Ingersoll-Rand Steelcraft: www.steelcraft.com.
5. Kinney.
6. Substitutions: See Section 01 2500 - Substitutions.

2.02 PERFORMANCE REQUIREMENTS

- A. Requirements for Hollow Metal Doors and Frames:
 1. Steel used for fabrication of frames shall comply with one or more of the following requirements; Galvannealed steel conforming to 3, cold-rolled steel conforming to 1, or hot-rolled pickled and oiled (HRPO) steel conforming to 2, Commercial Steel (CS) Type B for each.
 2. Accessibility: Comply with ICC A117.1 and ADA Standards.
 3. Glazed Lights: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings. Style: Manufacturer's standard.
 4. Hardware Preparations, Selections and Locations: Comply with NAAMM HMMA 830 and NAAMM HMMA 831 or 4 and 1 (SDI-100) in accordance with specified requirements.
 5. Zinc Coating for Typical Interior and/or Exterior Locations: Provide metal components zinc-coated (galvanized) and/or zinc-iron alloy-coated (galvannealed) by the hot-dip process in accordance with 1, with manufacturer's standard coating thickness, unless noted otherwise for specific hollow metal doors and frames.
 - a. Based on NAAMM HMMA Custom Guidelines: Provide at least A25/ZF75 (galvannealed) for interior applications, and at least A60/ZF180 (galvannealed) or G60/Z180 (galvanized) for corrosive locations.
 6. Finish: Baked-on Factory primed, for field finishing.
- B. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with the specified requirements for each type; for instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.

2.03 HOLLOW METAL FRAMES

- A. Comply with standards and/or custom guidelines as indicated for corresponding door in accordance with applicable door frame requirements.
- B. General:
 1. Comply with the requirements of grade specified for corresponding door.
 - a. Frames for Wood Doors: Comply with frame requirements specified in ANSI A250.8 for Level 2, 16 gage, minimum.
 - b. Door frames exceeding 4 feet wide at head: 14 gage.
 2. Finish: Factory primed, for field finishing.
 3. Provide mortar guard boxes for hardware cut-outs in frames to be installed in masonry or to be grouted.
 4. Miter corners of all frames unless otherwise noted.
- C. Interior Door Frames, Non-Fire Rated: Face welded type.
 1. Frame Metal Thickness: 16 gage, 0.053 inch (1.3 mm), minimum.
 2. Frame Finish: Factory primed and field finished.
- D. Frames for Wood Doors: Comply with frame requirements in accordance with corresponding door.
- E. Frames Wider than 48 inches (1219 mm): Reinforce with steel channel fitted tightly into frame head, flush with top.

2.04 ACCESSORIES

- A. Glazing: As specified in Section 08 8000 and as indicated on the Drawings.
- B. Astragals for Double Doors: Specified in Section 08 7100.
- C. Silencers: Resilient rubber, fitted into drilled hole; provide three on strike side of single door, three on center mullion of pairs, and two on head of pairs without center mullions.
- D. Temporary Frame Spreaders: Provide for factory- or shop-assembled frames.
- E. Frame Anchors: Fabricate from minimum 12 gage by 1 1/4 inch strap as required to attach to frame surround.
 - 1. Provide a minimum of 4 anchors per side jamb and 2 anchors per head.
 - 2. Side jamb anchors shall be spaced evenly and shall not exceed 28 inches on center. Top and bottom anchors to be located a minimum distance from top and bottom hinges.
- F. Floor Clips at Metal Studs: Fabricate from minimum 12 gage, 2 1/2 by 2 inch angle equal in length to stud width.
 - 1. Drill each floor clip for 2 floor fasteners and weld clips to frame.

2.05 FINISHES

- A. Primer: Rust-inhibiting, complying with ANSI A250.10, door manufacturer's standard, baked-on.
- B. Bituminous Coating: Asphalt emulsion or other high-build, water-resistant, resilient coating.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

- A. Coat inside of frames to be installed in masonry or to be grouted, with bituminous coating, prior to installation.
- B. Coat inside of other frames with bituminous coating to a thickness of 1/16 inch (1.6 mm).

3.03 INSTALLATION

- A. Install in accordance with the requirements of the specified door grade standard and NAAMM HMMA 840 and SDI-100.
- B. Install fire rated units in accordance with NFPA 80.
- C. Set frames plumb; attach securely to structure before removing temporary spreader bars.
- D. Coordinate frame anchor placement with wall construction.
- E. Grout frames in masonry construction, using hand trowel methods; brace frames so that pressure of grout before setting will not deform frames.
- F. Coordinate installation of wood doors in steel frames.
- G. Install door hardware as specified in Section 08 7100.
- H. Comply with glazing installation requirements of Section 08 8000.
- I. Coordinate installation of electrical connections to electrical hardware items.
- J. Touch up damaged factory finishes.
- K. Metal Stud Partitions: Spot grout steel frames.
 - 1. Apply spot grout at each jamb anchor clip and immediately insert gypsum panels into frame.

2. Solidly pack mineral fiber insulation behind frames after insulation of spot grout.
3. Coordinate and grout in place with spot grouting of jamb anchors, electrical whips, or conduit chases as required to route to electrical hardware items such as strikes, etc.

3.04 TOLERANCES

- A. Clearances Between Door and Frame: Comply with related requirements of specified frame standards or custom guidelines indicated in accordance with 1 or NAAMM HMMA 861.
- B. Maximum Diagonal Distortion: 1/16 inch (1.6 mm) measured with straight edge, corner to corner.

3.05 ADJUSTING

- A. Adjust for smooth and balanced door movement.

3.06 SCHEDULE

- A. Refer to Door and Interior Opening Schedule on the drawings.

END OF SECTION 08 1113

SECTION 08 1416
FLUSH WOOD DOORS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Flush wood doors; flush and flush glazed configuration; non-rated.
- B. Provision of wood doors of types noted and installation of their hardware.

1.02 RELATED REQUIREMENTS

- A. Section 06 2000 - Finish Carpentry.
- B. Section 08 1113 - Hollow Metal Doors and Frames.
- C. Section 08 7100 - Door Hardware.
- D. Section 08 8000 - Glazing.

1.03 REFERENCE STANDARDS

- A. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials; Current Edition.
- B. ANSI A135.4 - American National Standard for Basic Hardboard; 2012.
- C. ANSI A208.1 - American National Standard for Particleboard; 2009.
- D. 11
- E. AWI (QCP) - Quality Certification Program; Current Edition.
- F. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition; 2014, with Errata (2016).
- G. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards; 2021, with Errata.
- H. HPVA HP-1 - American National Standard for Hardwood and Decorative Plywood; 2020.
- I. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- J. WDMA I.S. 1A - Interior Architectural Wood Flush Doors; Window and Door Manufacturers Association; 2013. (ANSI/WDMA I.S. 1A)
- K. WI (CCP) - Certified Compliance Program (CCP); Current Edition.
- L. WI (MCP) - Monitored Compliance Program (MCP); Current Edition.

1.04 SUBMITTALS

- A. See Special Conditions - Submittals, for submittal procedures.
- B. Product Data: Indicate door core materials and construction; veneer species, type and characteristics.
- C. Shop Drawings: Illustrate door opening criteria, elevations, sizes, types, swings, undercuts required, special beveling, special blocking for hardware, factory machining criteria, identify cutouts for glazing.
- D. Samples: Submit four samples of door veneer, 6 x 6 inch (152.4 mm) in size illustrating wood grain, stain color, and sheen.
- E. Manufacturer's Installation Instructions: Indicate special installation instructions.
- F. Warranty, executed in Owner's name.

1.05 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum ten (10) years of documented experience.

1. Accredited participant in the specified certification program prior to the commencement of fabrication and throughout the duration of the project.
- B. Woodwork Quality Assurance Program:
 1. Provide labels 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 quality assurance program.
 3. Provide designated labels on installed products as required by quality assurance program.
 4. Submit documentation upon completion of installation that verifies this work is in compliance with specified requirements.

1.06 REGULATORY REQUIREMENTS

- A. Fire Door Construction: Conform to NFPA 252.
 1. Listed and classified by UL as suitable to for the purpose specified and indicated.
- B. Installed Fire Rated Door Assembly: Conform to NFPA 80 for fire-rating as scheduled as indicated.

1.07 DELIVERY, STORAGE, AND HANDLING

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

1.08 PROJECT CONDITIONS

- A. Coordinate the work with door opening construction, door frame and door hardware installation.

1.09 WARRANTY

- A. Warrant door against warp or twist in excess of 1/4 inch in any face including full diagonal. Replacement shall include finishing of new door, hardware damaged by malfunction of original door, and hanging in satisfactory operating condition. Period of warranty shall be for the life of the installation.
- B. Manufacturer Warranty: Provide manufacturer's warranty on interior doors for the life of the installation. Complete forms in Owner's name and register with manufacturer.
 1. Include coverage for delamination of veneer, warping beyond specified installation tolerances, defective materials, and telegraphing core construction.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Veneer Doors:
 1. Eggers Industries: www.eggersindustries.com.
 2. Graham Wood Doors: www.grahamdoors.com.
 3. Marshfield DoorSystems, Inc: www.marshfielddoors.com.
 4. VT Industries, Inc.; www.wtindustries.com.
 5. Algoma Hardwoods, Inc.; www.algomahardwoods.com.
 6. Substitutions: See Section 01 2500 - Substitutions.

2.02 DOOR TYPES

- A. Solid Core Door:
 1. Core: Mat-formed particleboard meeting requirements of ANSI A208.1, Grade 1-L-1.
 2. Stiles: Minimum 1-1/4 inch two ply edge strips glued to core, outer ply of hardwood to match face veneer with no finger joints.

- a. Outer ply to be a minimum of 5/8" thick face veneer material.
3. Top and Bottom Rails: Minimum 1-1/4 inch two ply end strips glued to core.
 - a. Solid hardwood rails at rabbeted door top rail / bottom rail of wood veneer transom.
4. Crossbands: 1/16 inch thick hardwood veneer.
5. Faces:
 - a. Plastic laminate as noted.
6. Edges:
 - a. 3 mil PVC edge bonding as noted.
7. Product: Same as Algoma Hardwoods, Inc.'s "Novodor"; Weyerhaeuser Co.'s "The Marshfield Series, Particleboard Core Door DPC-1"; VT Industries Solid Stile No. 5502; or approved equal.
8. Comply with AWI premium grade construction standards.

2.03 MATERIALS

- A. Hollow Metal Door Frames: As specified in Section 08 1113.
- B. Faces:
 1. High pressure laminate: Nevamar, color as selected by Architect to match existing.
 - a. Edges: Charter Industries 3mm PVC edge protection to match existing Nevamar plastic laminate.
- C. Vision Panel Frames:
 1. Fire-Rated Doors and Corridor Doors Requiring Fire Rated Glass: One-piece metal frame of type tested in complete door assembly bearing fire resistive label; corners neatly mitered; lapped corners not acceptable.
 2. Typical Doors: Metal type to match fire-rated frame in profile.

2.04 DOOR CONSTRUCTION

- A. Preparation: Verify size, design, and fire-resistive rating required for each opening.
- B. Manufacture doors in accordance with NWWDA I.S.1 Series unless otherwise noted.
- C. Bond stiles and rails to core material. Sand assembly to uniform thickness before applying crossbands.
- D. Undercut interior doors 1/4 inch from bottom of door to top of finish floor covering, unless otherwise noted.
- E. Meeting Guards and Astragals: Provide as required on fire-rated pairs and double egress doors. Machine as required for hardware.
- F. Pre-fit doors at factory and provide cutouts for mortise hardware according to templates and NWWDA. Drill holes for lever, turn piece and cylinder on both sides of all doors that have mortise locksets or latchsets with escutcheon plates. Holes not required for any given door will be covered by escutcheon plates.
- G. Bevel both stile edges 1/8 inch in two inches.
- H. Factory machine doors for hardware other than surface-mounted hardware, in accordance with hardware requirements and dimensions.
- I. Factory fit doors for frame opening dimensions identified on shop drawings.

2.05 FABRICATION

- A. Preparation: Verify size, design, and fire-resistive rating required for each opening.
- B. Manufacture doors in accordance with NWWDA I.S. 1-87 Series unless otherwise noted.
- C. Bond stiles and rails to core material. Sand assembly to uniform thickness before applying crossbands.

- D. Fabricate rail and stile doors in accordance with AWI premium standards. Provide for concealed closer rods in stiles where specified.
- E. Undercut interior doors 1/4 inch from bottom of door to top of finish floor covering, unless otherwise noted.
- F. Pre-fit doors at factory and provide cutouts for mortise hardware according to templates and NWWDA. Drill holes for lever, turn piece and cylinder on both sides of all doors that have mortise locksets or latchsets with escutcheon plates. Holes not required for any given door will be covered by escutcheon plates.
- G. Bevel both stile edges 1/8 inch in two inches.
- H. Provide rabbeted rail configurations where indicated on the drawings.

2.06 FINISH

- A. Steel (Vision Panel Frames): Grind welds smooth, chemically etch and apply one baked-on prime coat and one baked-on finish coat, color as selected.
- B. Stainless Steel (Astragals): Manufacturer's No. 4 finish.
- C. Seal door top edge with color sealer to match door facing.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that opening sizes and tolerances are acceptable.
- C. Do not install doors in frame openings that are not plumb or are out-of-tolerance for size or alignment.

3.02 INSTALLATION

- A. Install doors in accordance with manufacturer's instructions and AWI P-200 requirements.
 - 1. Install fire-rated doors in accordance with NFPA 80 requirements.
- B. Factory-Finished Doors: Do not field cut or trim; if fit or clearance is not correct, replace door.
- C. Trim non-rated door width by cutting equally on both jamb edges.
 - 1. Trim maximum of 3/4 inch (19 mm) off bottom edges.
- D. Machine cut for hardware.
- E. Coordinate installation of doors with installation of frames and hardware.
- F. Coordinate installation of glazing.
- G. Custom wood veneer transom panels to be installed with concealed or blind fastening systems. No exposed fasteners will be allowed.

3.03 INSTALLATION TOLERANCES

- A. Comply with specified quality standard for fit and clearance tolerances.
- B. Comply with specified quality standard for telegraphing, warp, and squareness.
- C. Maximum Diagonal Distortion (Warp): 1/8 inch (3 mm) measured with straight edge or taut string, corner to corner, over an imaginary 36 x 84 inches (915 X 2130 mm) surface area.
- D. Maximum Vertical Distortion (Bow): 1/8 inch (3 mm) measured with straight edge or taut string, top to bottom, over an imaginary 36 x 84 inches (915 X 2130 mm) surface area.
- E. Maximum Width Distortion (Cup): 1/8 inch (3 mm) measured with straight edge or taut string, edge to edge, over an imaginary 36 x 84 inches (915 X 2130 mm) surface area.

3.04 ADJUSTING

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

3.05 SCHEDULE

- A. Refer to Door and Interior Opening Schedule on Architectural Drawings.

END OF SECTION 08 1416

SECTION 08 3100
ACCESS DOORS AND PANELS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Access door and frame units, fire-rated and non-fire-rated, in wall and ceiling locations.

1.02 RELATED REQUIREMENTS

- A. Section 09 2216 - Non-Structural Metal Framing: Openings in partitions and ceilings.
- B. Section 09 9123 - Interior Painting: Field paint finish.
- C. Section 22 0500 - Basic Plumbing Materials and Methods.
- D. Section 23 0500 - Basic Mechanical Materials and Methods: Access panels related to mechanical/plumbing systems.
- E. Section 26 0500 - Basic Electrical Materials and Methods: Access panels related to electrical systems.

1.03 REFERENCE STANDARDS

- A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- B. 11
- C. 11
- D. 11
- E. UL (FRD) - Fire Resistance Directory; Current Edition.

1.04 SUBMITTALS

- A. See Special Conditions - Submittals, for submittal procedures.
- B. Product Data: Provide sizes, types, finishes, hardware, scheduled locations, and details of adjoining work.
- C. Shop Drawings: Indicate exact position of each access door and/or panel unit.
- D. Manufacturer's Installation Instructions: Indicate installation requirements and rough-in dimensions.
- E. Project Record Documents: Record actual locations of each access unit.

1.05 REGULATORY REQUIREMENTS

- A. Conform to applicable code for fire rated access doors.
 - 1. Provide access doors of fire rating equivalent to the fire rated assembly in which they are to be installed.
- B. Provide products listed and labeled by UL as suitable for the purpose specified and indicated.
- C. Provide certificate of compliance from authority having jurisdiction indicating approval of fire rated doors.

1.06 PROJECT CONDITIONS

- A. Coordinate the work with other work requiring access doors.

PART 2 PRODUCTS

2.01 ACCESS DOORS AND PANELS ASSEMBLIES

- A. Wall-Mounted Units:
 - 1. Material: Steel.
 - 2. Size: 12 inch by 12 inch (305 mm by 305 mm).

3. Door/Panel: Hinged, standard duty, with tool-operated spring or cam lock and no handle.
 4. Tool-operated spring or cam lock; no handle.
 5. Wall Mounting Criteria: Provide surface-mounted face frame and door surface flush with frame surface.
- B. Fire-Rated Wall-Mounted Units:
1. Wall Fire-Rating: As indicated on drawings.
 2. Material: Steel.
 3. Size: 12 inch by 12 inch (305 mm by 305 mm).
 4. Insulated, double skin door panel.
 5. Tool-operated spring or cam lock; no handle.
- C. Ceiling-Mounted Units:
1. Material: Steel.
 2. Size - Lay-In Grid Ceilings: To match module of ceiling grid.
 3. Size in Other Ceilings: 24 by 24 inch (610 by 610 mm), unless otherwise indicated.
 4. Door/Panel: Hinged, standard duty, with tool-operated spring or cam lock and no handle.
 5. Tool-operated spring or cam lock; no handle.
- D. Fire-Rated Ceiling-Mounted Units:
1. Ceiling Fire-Rating: As indicated on drawings.
 2. Panel Material: Steel.
 3. Size: 24 by 24 inch (610 by 610 mm), unless otherwise indicated.
 4. Door/Panel: Hinged, standard duty, with tool-operated spring or cam lock and no handle.
 5. Tool-operated spring or cam lock; no handle.

2.02 MANUFACTURERS

- A. Milcor.
- B. Jensen Industries, Inc.
- C. J.L. Industries.
- D. Substitutions: See Section 01 2500 - Substitutions.

2.03 ACCESS DOOR UNITS - WALLS AND CEILINGS

- A. Door and Frame Units: Formed steel.
1. Frames and flanges: 0.058 inch (1.5 mm) steel.
 2. Door panels: 0.070 inch (1.8 mm) single thickness steel sheet.
 3. Door panels: 0.070 inch (1.8 mm) double sheet with integral non-combustible insulation filler.
 4. Units in Fire-Rated Assemblies: Fire rating as required by applicable code for fire-rated assembly that access doors are being installed.
 5. Steel Finish: Primed.
 6. Stainless Steel Finish: No. 4 brushed finish.
 7. Door/Panel Size: As indicated on the drawings.
 8. Hardware:
 - a. Hinge: 175 degree steel piano hinge with non-removable pin.
 - b. Latch/Lock: Screw driver slot for quarter turn cam latch.
 9. Prime coat with baked on primer.
 10. Any access panel units installed inside of MRI Exam Room shall be aluminum, non-ferrous construction.

2.04 FABRICATION

- A. Weld, fill, and grind joints to ensure flush and square unit.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that rough openings for door and frame are correctly sized and located.
- B. Begin installation only after substrates have been properly prepared, and if the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 INSTALLATION

- A. Install access doors in accordance with manufacturer's instructions and at locations noted or otherwise authorized by the Architect. Major subcontractors shall provide access doors as required to maintain access to their work. Coordinate locations with Architect.
- B. Finish access doors wherever required to gain access to valves, pull boxes, etc. above "hard" ceilings or in walls. MEP/FP contractors required to provide access panels required for their work.
- C. Ensure correct types and sizes at proper locations.
- D. Securely attach frames to structure and ensure doors operate smoothly and are free from warp, twist, or distortion.
- E. Install frames plumb and level in openings, and secure units rigidly in place.
- F. Position units to provide convenient access to concealed equipment when necessary.

3.03 CLEANING

- A. Thoroughly clean surface of grease, oil, or other impurities, touch up abraded prime coats, and otherwise prepare for finish painting where required.

END OF SECTION 08 3100

SECTION 08 4229
AUTOMATIC ENTRANCES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Operators for doors provided in other sections.
- B. Controllers, actuators and safety devices.
- C. Service of existing automatic operations from salvage to be reinstalled in new work.

1.02 RELATED REQUIREMENTS

- A. Section 08 1113 - Hollow Metal Doors and Frames.
- B. Section 08 1416 - Flush Wood Doors: Plastic Laminate veneered doors.
- C. Section 08 4229.23 - Sliding Automatic Entrances: Coordination.
- D. Section 08 4313 - Aluminum-Framed Storefronts: Hardware coordination and equals.
- E. Section 08 7100 - Door Hardware.
- F. Section 08 8000 - Glass and Glazing.

1.03 REFERENCES

- A. BHMA A156.10 - Power Operated Pedestrian Doors; 2017.
- B. ITS (DIR) - Directory of Listed Products; Current Edition.
- C. NEMA MG 1 - Motors and Generators; 2021.
- D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL (DIR) - Online Certifications Directory; Current Edition.
- G. UL 325 - Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Special Conditions - Submittals, for submittal procedures.
- B. Shop Drawings:
 - 1. Indicate layout and dimensions; head, jamb, and sill conditions; elevations; components, anchorage, recesses, materials, and finishes, electrical characteristics and connection requirements.
 - 2. Identify installation tolerances required, assembly conditions, routing of service lines and conduit, and locations of operating components and boxes.
- C. Product Data: Include system components, sizes, features, and finishes.
- D. Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention, and manufacturer's hardware and component templates.
- E. Project Record Documents: Record actual locations of concealed equipment, services, and conduit.
- F. Maintenance Data: Include manufacturer's parts list and maintenance instructions for each type of hardware and operating component.
- G. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.
- B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience, and a member of AAADM.
- C. Installer Qualifications: Company specializing in performing the work of this section with minimum three years of experience and approved by manufacturer.

1.06 PROJECT CONDITIONS

- A. Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner.

1.07 WARRANTY

- A. Correct defective Work within a five year period after Date of Substantial Completion.

1.08 MAINTENANCE SERVICE

- A. Provide service and maintenance of operating equipment for one year from Date of Substantial Completion.

1.09 MAINTENANCE PRODUCTS

- A. Provide wrenches and tools required for maintenance of equipment.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Automatic Entrance (Swing) Door Operations:
 - 1. Access Technologies: www.stanleyaccess.com.
 - 2. Substitutions: Not permitted.

2.02 POWER OPERATED DOORS

- A. Power Operated Doors: Provide products that comply with NFPA 101 and requirements of authorities having jurisdiction; provide equipment selected for actual door weight and for light pedestrian traffic, unless otherwise indicated.
 - 1. Swinging Fire Door Operators: In addition to other requirements, provide equipment ITS (DIR) or UL (DIR) listed as a fire door operator with automatic closer.
 - 2. Swinging Door Operators: Fully adjustable for opening and closing speeds, checking speeds, and hold-open time; in the event of power failure, disengage operator allowing door to function as a door with a spring closer.
- B. Swinging Doors with Full Power Operators: Comply with BHMA A156.10; safeties required.
 - 1. Comply with UL 325; acceptable evidence of compliance includes UL (DIR) or ITS (DIR) listing or test report by testing agency acceptable to authorities having jurisdiction.
 - 2. Force Required to Set Door in Motion When Unpowered: 30 pound-force (133 N), maximum, measured at 1 inch (25.4 mm) from the latch edge of the door at any point in the closing cycle.
 - 3. Door Operation:
 - a. Opening Cycle: The adjustable speed operator mechanically powers the drive shaft and the torque control maintains constant speed throughout the opening cycle regardless of stack pressures or wind speed. Operator shall allow manual door operation with operational forces as indicated to fully open the door applied at 1" (25 mm) from the lach edge of the door.
 - 1) Manual push force shall be adjustable from 5 lbf to 30 lbf maximum.
 - b. Hold Open: The operator shall stop and hold the door open at the selected door opening angle for an adjustable period of time (1.5 seconds to 30 seconds).

- c. Closing Cycle: Spring close with speed controlled power assist.
 - 1) Upon loss of power, dynamic bracking will control the door ensuring controlled closing.
 - 2) Selectable Torque Control: Automatically adjusts torque without changing the closing speed of the operator.
 - (a) When the torque control is activated, the closing speed shall remain constant regardless of slack pressures or wind speed.
 - (b) Torque Cancellation: The torque control is deactivated whenever there is a signal received from door mounted sensors.
 - (c) The torque control is disabled during manual use of the door.
- d. Stack Pressure Compensation: Operator shall counteract positive stack pressures, negative stack pressures, and sudden changes of stack pressures. The operator never allows the door to open or close faster than the speed control settings, regardless of pressures.
- e. Obstruction Control: The operator will stop and reverse the door movement.

2.03 DOOR OPERATORS

- A. Swinging Door Operators - General Requirements: Comply with BHMA A156.10, BHMA A156.19, and UL 325, as applicable. Electric surface mounted overhead.
 - 1. Select equipment to accommodate heavy pedestrian traffic and weight of doors.
 - 2. Provide equipment capable of operating, holding open, and closing doors under positive and negative wind pressures of 40 lbs/sf.
 - 3. Operating Temperature Range: Minus 20 to plus 140 degrees F (minus 7 to plus 60 degrees C) ambient.
 - 4. Provide operators that are fully adjustable for opening and closing speeds, checking speeds, and hold-open time.
 - 5. Swinging Door Operators: Provide for manual open and close operation of door leaves in the event of power failure.
 - 6. Conform to applicable code for automatic release of control drive unit to permit manual opening of doors.
 - 7. Finish exposed components to match door and door hardware finish.
 - 8. Electric Operators: 1/8 hp minimum, self-contained, gear driven, with release clutch.
 - 9. Infrared Threshold Safety Sensor.
 - 10. Provide additional contacts for interface of operator with fire alarm system for fire-rated door.
- B. Swinging Door Operator: Electric surface mounted overhead.
 - 1. Operation: Power open, spring close operation.
 - 2. Variable speed control for opening and closing cycles.
 - 3. "Push" Side Actuator: Push plate/card reader. Reference plans.
 - 4. "Pull" Side Actuator: Push plate. Reference plans.
 - 5. "Push" Side Safety: Door-mounted.
 - 6. "Pull" Side Safety: Door-mounted.
 - 7. Hold Open: Toggle switch at inside head of doors; deactivate hold-open on activation of fire alarm system.
 - 8. Product: Magic Force by Stanley Access Technologies or approved equal.

2.04 CONTROLLERS, ACTUATORS, AND SAFETIES

- A. Directional Motion Sensor Actuator: Passive infrared; distance of control sensitivity adjustable. Provide motion sensor at Doors.
- B. Hands Free Actuator: Wall mounted, recessed microwave motion sensor in single or double gang configuration to meet project requirements. Provide custom cover plate for color and

graphic. Same as BEA's "Model MS31 Tough Less Switch" or approved equal. This device will replace originally specified push plate actuator(s) denoted in Paragraph 2.03.

- C. Swinging Door Safety Device: Door-mounted proximity detector device arranged to prevent operation of door when persons or obstructions are in the swing zone.

2.05 ELECTRICAL CHARACTERISTICS AND COMPONENTS

- A. Electrical Characteristics:
 - 1. 5 rated load amperes.
 - 2. 120 volts, single phase, 60 Hz.
 - 3. Refer to Section 26 0100 - Basic Electrical Requirements: Electrical connections.
- B. Motors: NEMA MG 1 (110V/10 amps).
- C. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.
- D. Disconnect Switch: Factory mount disconnect switch in control panel.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are ready to receive work and dimensions are as indicated on shop drawings.
- B. Verify that electric power is available, at the correct location, and is of the correct characteristics.
- C. Verify condition of existing door unit.

3.02 INSTALLATION

- A.
- B. Provide for thermal expansion and contraction of door and frame units and live and dead loads that may be transmitted to operating equipment.
- C. Provide for dimensional distortion of components during operation.
- D. General contractor to coordinate installation of operators with door assemblies under other specifications.
- E. Coordinate installation of components with related and adjacent work; level and plumb.
- F. Service existing door unit including complete diagnostics, replacement of worn components and cleaning.

3.03

- A.
- B. Adjust existing door unit to function and work properly.

3.04

- A.

3.05 DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate operation, operating components, adjustment features, and lubrication requirements.

END OF SECTION 08 4229

SECTION 08 4229.23
SLIDING AUTOMATIC ENTRANCES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. This Section includes the following types of automatic entrance doors:
 - 1. Interior, telescoping slide sliding automatic entrance door systems, from salvage.
 - 2. Interior, automatic swing door with manual split fold (trackless) door package.
 - 3. Service of existing automatic sliding door assembly from salvage to be installed in new work.

1.02 RELATED REQUIREMENTS

- A. Section 07 9200 - Joint Sealants: For caulking to the extent not specified in this section.
- B. Section 08 4229 - Automatic Entrances: Coordination.
- C. Section 08 7100 - Door Hardware: For hardware to the extent not specified in this Section.
- D. Section 08 8000 - Glazing: For materials and installation requirements of glazing for automatic entrance doors.
- E. Division 26 Sections for electrical connections including conduit and wiring for automatic entrance door operators.

1.03 REFERENCE STANDARDS

- A. American Association of Automatic Door Manufacturers (AAADM).
- B. AAMA 607.1 - Clear Anodic Finishes for Architectural Aluminum, American Architectural Manufacturers Association, current edition.
- C. AAMA 611 Voluntary Specification for Anodized Architectural Aluminum, American Architectural Manufacturers Association, current edition.
- D. AAMA 701 Voluntary Specification for Pile Weatherstripping and Replaceable Fenestration Weatherseals, American Architectural Manufacturers Association, current edition.
- E. BHMA A156.5 - Cylinders and Input Devices for Locks; 2014 (ANSI A156.5).
- F. BHMA A156.10 - Power Operated Pedestrian Doors; 2017 (ANI A156.10).
- G. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.
- H. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2014.
- I. IBC: International Building Code; 2009.
- J. NFPA 70 - National Electric Code, current edition.
- K. NFPA 101 - Life Safety Code, current edition.
- L. UL 325 - Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems.

1.04 DEFINITIONS

- A. Activation Device: Device that, when actuated, sends an electrical signal to the door operator to open the door.
- B. Safety Device: Device that prevents a door from opening or closing, as appropriate.

1.05 PERFORMANCE REQUIREMENTS

- A. Provide automatic entrance door assemblies capable of withstanding structural loads and thermal movements based on testing manufacturer's standard units in assemblies similar to those indicated for this Project.

- B. Operating Range: Minus 30 deg F (Minus 34 deg C) to 130 deg F (54 deg C).
- C. Opening-Force Requirements for Egress Doors: Not more than 50 lbf (222 N) required to manually set door in motion if power fails, and not more than 15 lbf (67 N) required to open door to minimum required width.
- D. Closing-Force Requirements: Not more than 30 lbf (133 N) required to prevent door from closing.

1.06 SUBMITTALS

- A. See Special Conditions - Submittals: For submittal procedures.
- B. Shop Drawings:
 - 1. Indicate layout and dimensions; head, jamb, and sill conditions; elevations; components, anchorage, recesses, materials, and finishes, electrical characteristics and connection requirements.
 - 2. Identify installation tolerances required, assembly conditions, routing of conduit, and locations of operating components and boxes.
- C. Product Data: Provide data on system components, sizes, features, and finishes.
- D. Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention, and manufacturer's hardware and component templates.
- E. Maintenance Contract.
- F. Project Record Documents: Record actual locations of concealed equipment, services, and conduit.
- G. Maintenance Data: Include manufacturer's parts list and maintenance instructions for each type of hardware and operating component.
- H. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Wrenches and other tools required for maintenance of equipment.

1.07 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained for installation and maintenance of units required for this Project.
- B. Manufacturer Qualifications: A qualified manufacturer with a manufacturing facility certified under ISO 9001 and with company certificate issued by AAADM.
- C. Certifications: Automatic sliding door systems shall be certified by the manufacturer to meet performance design criteria in accordance with the following standards:
 - 1. ANSI/BHMA A156.10.
 - 2. NFPA 101.
 - 3. Underwriter's Laboratories 325 (UL) listed.
 - 4. IBC
- D. Source Limitations: Obtain automatic entrance door assemblies through one source from a single manufacturer.
- E. 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.
- F. Emergency-Exit Door Requirements: Comply with requirements of authorities having jurisdiction for automatic entrance doors serving as a required means of egress.

1.08 PROJECT CONDITIONS

- A. Field Measurements: General Contractor shall verify openings to receive automatic entrance door assemblies by field measurements before fabrication and indicate measurements on Shop Drawings.
- B. Mounting Surfaces: General Contractor shall verify all surfaces to be plumb, straight and secure; substrates to be of proper dimension and material.

1.09 COORDINATION

- A. Templates: Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing automatic entrance doors to comply with indicated requirements.
- B. Electrical System Roughing-in: Coordinate layout and installation of automatic entrance door assemblies with connections to power supplies.

1.10 WARRANTY

- A. Automatic Entrance Doors shall be free of defects in material and workmanship for a period of two (2) years from the date of substantial completion.
- B. During the warranty period the Owner shall engage a factory-trained technician to perform service and affect repairs. A safety inspection shall be performed after each adjustment or repair and a completed inspection form shall be submitted to the Owner.
- C. During the warranty period all warranty work, including but not limited to emergency service, shall be performed during normal working hours.

PART 2 PRODUCTS

2.01 AUTOMATIC ENTRANCE DOORS

- A. Stanley Access Technologies; Telescoping sliding automatic entrance package from salvage.
- B. Stanley Access Technologies; Automatic entrance door with manual split fold (trackless 1 door package; "Dura-Care 7600 Series, Split Fold").

2.02 MATERIALS

- A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 - 1. Headers, stiles, rails, and frames: 6063-T6
 - 2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
 - 3. Sheet and Plate: ASTM B 209.
- B. Sealants and Joint Fillers: Reference Section 07 9200 - Joint Sealants.

2.03 AUTOMATIC ENTRANCE DOOR ASSEMBLIES

- A. Provide manufacturer's standard automatic entrance door assemblies including doors, sidelites, framing, headers, carrier assemblies, roller tracks, door operators, activation and safety devices, and accessories required for a complete installation.
- B. Single Slide Telescoping Automatic Entrance Doors:
 - 1. Telescoping Single Slide Sliding Doors (Type 1) from salvage:
 - a. Configuration: Two sliding leaves with one full sidelight.
 - b. Traffic Pattern: Two-way.
 - c. Emergency Breakaway Capability: Sliding leaves only.
 - d. Mounting: Overhead concealed, between jambs.
 - e. Size: 8'-0" package width.
 - f. Same as Besam Entrance Solutions; "Model SL-500 Telescoping Series".
- C. Single Swing Automatic Entrance Door with manual split fold side panels:
 - 1. Configuration: One (1) automatic operated swing door with split fold side panels.
 - 2. Emergency Breakaway: Split fold side panels only.

3. Monitoring: Overhead concealed, between jambs.
4. Provide with auto locking system to be operated with card reader access.

2.04 COMPONENTS

- A. Framing Members: Manufacturer's standard extruded aluminum reinforced as required to support imposed loads.
 1. Nominal Size: 1 ¾ inch by 4 ½ inch (45 by 115 mm).
- B. Stile and Rail Aluminum Doors: Manufacturer's standard 1 ¾ inch (45 mm) thick glazed doors with extruded-aluminum tubular stile and rail members. Incorporate concealed tie-rods that span full length of top and bottom rails or mechanically fasten corners with reinforcing brackets that are welded.
 1. Glazing Stops and Gaskets: Snap-on, extruded-security aluminum stops and preformed gaskets.
 2. Acoustical Seals: Units at Procedure Rooms to be provided with resilient continuous acoustical seals at perimeter of sliding door assembly. Provide additional applied aluminum stop on exterior side of frame, strike side.
 3. Stile Design: Narrow stile; 2 inch (51 mm) nominal width.
 4. Bottom Rail Design: 10 inch (254 mm) nominal height.
 5. Muntin Bars: Horizontal tubular rail member for each door; 2 inch (51 mm) nominal width.
- C. Glazing: Performed under Section 08 8000 - Glazing. All Glazing furnished "by others" shall be 3/8" tempered laminated glass.
- D. Headers: Fabricated from extruded aluminum and extending full width of automatic entrance door units to conceal door operators, carrier assemblies, and roller tracks. Provide hinged or removable access panels for service and adjustment of door operators and controls. Secure panels to prevent unauthorized access.
 1. Mounting: Concealed, with one side of header flush with framing.
 2. Capacity: Capable of supporting doors up to 400 lb (182 kg) per leaf over spans up to 14 feet (4.3 m) without intermediate supports.
- E. Carrier Assemblies and Overhead Roller Tracks: Manufacturer's standard carrier assembly that allows vertical adjustment of at least 1/8 inch; consisting of urethane with precision steel lubricated ball-bearing wheels, operating on a continuous roller track. Support doors from carrier assembly by 2 inch diameter anti-riser wheels with factory adjusted cantilever and pivot assembly. Minimum two ball-bearing roller wheels and two anti-rise rollers for each active leaf.
 1. Minimum Load Wheel Diameter: 2 1/2 inch (64 mm).
- F. Thresholds: All units to be provided without thresholds, trackless applications, typical. Provide recessed, concealed guide assembly at sliding door assembly.
- G. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, non-staining, non-bleeding fasteners and accessories compatible with adjacent materials.
- H. Signage: Provide signage in accordance with ANSI/BHMA A156.10.

2.05 DOOR OPERATORS

- A. Provide door operators of size recommended by manufacturer for door size, weight, and movement; for condition of exposure; and for long-term, operation under normal traffic load for type of occupancy indicated.
- B. Electromechanical Operators: Self-contained overhead unit powered by a minimum of 1/4 horsepower, permanent-magnet DC motor with gear reduction drive, microprocessor controller; and encoder.
 1. Operation: Power opening and power closing.
 2. Features:
 - a. Adjustable opening and closing speeds.

- b. Adjustable back-check and latching.
 - c. Adjustable braking.
 - d. Adjustable hold-open time between 0 and 30 seconds.
 - e. Obstruction recycle.
 - f. On/Off switch to control electric power to operator.
 - g. Variable rate open/closed speed control.
 - h. Closed loop speed control with active braking and acceleration.
 - i. Variable obstruction recycle time delay.
 - j. Self adjusting stop position.
 - k. Self adjusting closing compression force.
 - l. Optional Switch to open/Switch to close operation.
 - m. Mounting: Concealed.
 - n. Drive System: Synchronous belt type.
- C. Electrical service to door operators shall be provided under Division 16 Electrical. Minimum service to be 120 VAC, 5 amps.

2.06 ELECTRICAL CONTROLS

- A. Electrical Control System: Electrical control system shall include a microprocessor controller and position encoder. The encoder shall monitor revolutions of the operator shaft and send signals to microprocessor controller to define door position and speed. Systems utilizing external magnets and magnetic switches are not acceptable. A single controller shall be capable of controlling up to 2 operators per entrance system.
- B. Life Cycle Data Counter: The microprocessor control shall incorporate a non-re-settable counter to track door operation cycles.
- C. Controller Protection: The microprocessor controller shall incorporate the following features to ensure trouble free operation:
- 1. Automatic Reset Upon Power Up
 - 2. Fuse Protection
 - 3. Electronic Surge Protection
 - 4. Internal Power Supply Protection.
 - 5. Software "Watchdog" protection in the case of software malfunction.
- D. Soft Start/Stop: A "soft-start" "soft-stop" motor driving circuit shall be provided for smooth normal opening and recycling.
- E. Safety Search Circuitry: Provide system to recycle the sliding panels when an obstruction is encountered during the closing cycle. If an obstruction is detected, the system shall search for that object on the next closing cycle by reducing door closing speed prior to the previously encountered obstruction location, and will continue to close in check speed until doors are fully closed, at which time the doors will reset to normal speed. If obstruction is encountered again, the door will come to a full stop. The doors shall remain stopped until obstruction is removed and operate signal is given, resetting the door to normal operation.
- F. Programmable Controller: Microprocessor controller shall be programmable and shall be designed for connection to a local configuration tool. Local configuration tool shall be software driven and shall be utilized via Palm® handheld interface. The following parameters may be adjusted via the configuration tool.
- 1. Operating speeds and forces as required to meet ANSI/BHMA A156.10.
 - 2. Adjustable and variable features as specified in 2.05, B., 2.
 - 3. Reduced opening position.
 - 4. Firmware update.
 - 5. Trouble Shooting
 - a. I/O Status.

- b. Electrical component monitoring including parameter summary.
 - c. Entrance profile copy/paste.
6. Software for local configuration tool shall be available as a free download from the sliding automatic entrance manufacturer's internet site.

2.07 ACTIVATION AND SAFETY DEVICES

- A. Interior Side "Hands Free" Actuator: Wall mounted, recessed microwave motion sensor in single or double gang configuration to meet project requirements. Provide custom cover plate for color and graphic. Same as BEA's "Model MS08 Touch Less Switch" or approved equal. This device will replace originally specified push plate actuator(s), where noted.
- B. Exterior Side "Hands Free" Actuator: Wall mounted card reader, by security contractor.
- C. Photoelectric Beams Safety Device: Include a minimum of two (2) doorway holding beams. Photoelectric beams shall be pulsed infrared type, including sender receiver assemblies for recessed mounting.

2.08 HARDWARE

- A. Provide units in sizes and types recommended by automatic entrance door and hardware manufacturers for entrances and uses indicated.
- B. Emergency Breakaway Feature: Provide release hardware that allows panel(s) to swing out in direction of egress to full 90 degrees from any position in sliding mode. Maximum force to open panel shall be 50 lbf (222 N) according to ANSI/BHMA A156.10. Interrupt powered operation of panel operator while in breakaway mode.
 - 1. Emergency breakaway feature shall include at least one adjustable detent device mounted in the top of each breakaway panel to control panel breakaway force.
- C. Control Switch: Provide manufacturer's standard header mounted rocker switches to allow for full control of the automatic entrance door. Controls to include, but are not limited to:
 - 1. Power On/Off
 - 2. Reduced Opening
 - 3. Open/Closed/Automatic
- D. Acoustical Door Sweeps:
 - 1. Resilient door seal, similar to clean door assemblies.

2.09 FABRICATION

- A. Factory fabricates automatic entrance door assembly components to designs, sizes, and thickness indicated and to comply with indicated standards.
 - 1. Form aluminum shapes before finishing.
 - 2. Use concealed fasteners to greatest extent possible.
 - a. Where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
 - b. Reinforce members as required to receive fastener threads.
- B. Framing: Provide automatic entrance doors as prefabricated assemblies.
 - 1. Fabricate tubular and channel frame assemblies with manufacturer's standard mechanical or welded joints. Provide sub-frames and reinforcement as required for a complete system to support required loads.
 - 2. Perform fabrication operations in manner that prevents damage to exposed finish surfaces.
 - 3. Form profiles that are sharp, straight, and free of defects or deformations.
 - 4. Prepare components to receive concealed fasteners and anchor and connection devices.
 - 5. Fabricate components with accurately fitted joints with ends coped or mitered to produce hairline joints free of burrs and distortion.

- C. Doors: Factory fabricated and assembled in profiles indicated. Reinforce as required to support imposed loads and for installing hardware.
- D. Door Operators: Factory fabricated and installed in headers, including adjusting and testing.
- E. Glazing: Fabricate framing with minimum glazing edge clearances for thickness and type of glazing indicated.
- F. Hardware: Factory install hardware to the greatest extent possible; remove only as required for final finishing operation and for delivery to and installation at Project site.

2.10 ALUMINUM FINISHES

- A. Class I, Clear Anodic Finish: AA-M12C22A41 Clear Anodic Finish: as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.7 mils (0.018 mm) thick minimum complying with AAMA 611, and the following:
 - 1. AAMA 607.1

PART 3 EXECUTION

3.01 INSPECTION

- A. Examine conditions for compliance with requirements for installation tolerances, header support, and other conditions affecting performance of automatic entrance doors. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Do not install damaged components. Fit frame joints to produce joints free of burrs and distortion. Rigidly secure non-movement joints.
- B. Entrances: Install automatic entrance doors plumb and true in alignment with established lines and grades without warp or rack of framing members and doors. Anchor securely in place.
 - 1. Install surface-mounted hardware using concealed fasteners to greatest extent possible.
 - 2. Set headers, carrier assemblies, tracks, operating brackets, and guides level and true to location with anchorage for permanent support.
- C. Door Operators: Connect door operators to electrical power distribution system as specified in Division 26 Sections.
- D. Glazing: Install glazing as specified in Section 08 8000 - Glazing.
- E. Sealants: Comply with requirements specified in Section 07 9200 - Joint Sealants to provide weather tight installation.
- F. Service existing door unit including complete diagnostics, replacement of worn components and cleaning.

3.03 FIELD QUALITY CONTROL

- A. Testing Services: Factory Trained Installer shall test and inspect each automatic entrance door to determine compliance of installed systems with applicable ANSI standards.

3.04 ADJUSTING

- A. Adjust door operators, controls, and hardware for smooth and safe operation, for weather-tight closure, and complying with requirements in ANSI/BHMA A156.10.

3.05 CLEANING AND PROTECTION

- A. Clean glass and aluminum surfaces promptly after installation. Remove excess glazing and sealant compounds, dirt, and other substances. Repair damaged finish to match original finish. Comply with requirements in Division 8 Section "Glazing", for cleaning and maintaining glass.

END OF SECTION 08 4229.23

**SECTION 08 7100
DOOR HARDWARE**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Hardware for wood doors.
- B. Finish Hardware.
- C. Templates.
- D. Electrically operated and controlled hardware.
- E. Lock cylinders for doors that hardware is specified in other sections.
- F. Hardware List.
- G. All such services reasonable and incidental to furnishing of such hardware including, survey of existing conditions and coordination of salvaged and reused hardware.

1.02 RELATED REQUIREMENTS

- A. Section 06 2000 - Finish Carpentry: Installation.
- B. Section 08 1113 - Hollow Metal Doors and Frames.
- C. Section 08 1416 - Flush Wood Doors.
- D. Section 08 4229 - Automatic Entrances: Power operators.
- E. Section 08 4229.23 - Sliding Automatic Entrances.
- F. Section 26 0530 - Wiring Methods: Coordination with work in this section.

1.03 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- B. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- C. BHMA A156.1 - Standard for Butts and Hinges; 2021.
- D. BHMA A156.2 – Bored and Preassembled Locks and Latches; 2022.
- E. BHMA A156.3 - Exit Devices; 2020.
- F. BHMA A156.4 - Door Controls - Closers; 2019.
- G. BHMA A156.6 - Standard for Architectural Door Trim; 2021.
- H. BHMA A156.7 - Template Hinge Dimensions; 2016.
- I. BHMA A156.8 - Door Controls - Overhead Stops and Holders; 2021.
- J. BHMA A156.12 – Interconnected Locks; 2022.
- K. BHMA A156.15 - Release Devices - Closer Holder, Electromagnetic and Electromechanical; 2021.
- L. BHMA A156.16 – Auxiliary Hardware; 2023.
- M. BHMA A156.18 - Materials and Finishes; 2020.
- N. BHMA A156.23 - Electromagnetic Locks; 2017.
- O. BHMA A156.31 - Electric Strikes and Frame Mounted Actuators; 2019.
- P. BHMA A156.115 – Hardware Preparation in Steel Doors and Frames; 2016.
- Q. BHMA A156.115W - Hardware Preparation in Wood Doors with Wood or Steel Frames; 2006.

- R. DHI (LOCS) – Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames; 2004.
- S. DHI WDHS.3 – Recommended Locations for Architectural Hardware for Flush Wood Doors; 1993; Also in WDHS-1/WDHS-5 Series, 1996.
- T. ITS (DIR) - Directory of Listed Products; Current Edition.
- U. UL (DIR) - Online Certifications Directory; Current Edition.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the manufacture, fabrication, and installation of products that door hardware is installed on.
- B. Furnish templates for door and frame preparation to manufacturers and fabricators of products requiring internal reinforcement for door hardware.
- C. Convey Owner's keying requirements to manufacturers.
- D. Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner.

1.05 SUBMITTALS

- A. See Special Conditions - Submittals, for submittal procedures.
- B. Product Data: Manufacturer's catalog literature for each type of hardware, marked to clearly show products to be furnished for this project, and includes construction details, material descriptions, finishes, and dimensions and profiles of individual components.
- C. Hardware Schedules: Minimum of five copies of complete detailed hardware schedule referenced to the Architect's hardware group numbers and hardware types. Note in cover letter variations from specified hardware groups stating changes and reasons for changes. The Architect will review only those groups which are referenced in cover letter.
 - 1. Hardware Schedule: Minimum of five copies of complete detailed hardware schedule referenced to the Architect's hardware group numbers and hardware types. Note in cover letter variations from specified hardware groups stating changes and reasons for changes. The Architect will review only those groups which are referenced in cover letter.
- D. Keying Schedule: Submit for approval of Owner.
- E. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.
- F. Maintenance Data: Include data on operating hardware, lubrication requirements, and inspection procedures related to preventative maintenance.
- G. Warranty: Submit manufacturer's warranty and ensure that forms have been completed in Owner's name and registered with manufacturer for any component which has a warranty which extends beyond the standard one year warranty for the project.

1.06 QUALITY ASSURANCE

- A. Standards for Fire-Rated Doors: Maintain one copy of each referenced standard on site, for use by Architect and Contractor.
- B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.
- C. Installer Qualifications: Company specializing in performing work of the type specified for commercial door hardware with at least three years of documented experience.
- D. Supplier Qualifications: Company with certified Architectural Hardware Consultant (AHC) and Electrified Hardware Consultant (EHC) to assist in work of this section.

1.07 REGULATORY REQUIREMENTS

- A. Conform to applicable code for requirements applicable to fire rated doors and frames.
- B. All Hardware on Fire-Rated Doors: Listed and classified by UL or ITS (Warnock Hersey) as suitable for the purpose specified and indicated.

1.08 DELIVERY, STORAGE, AND HANDLING

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

1.09 COORDINATION

- A. Coordinate the work with other directly affected sections involving manufacture or fabrication of internal reinforcement for door hardware.
- B. Furnish templates for door and frame preparation.
- C. Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner.
- D. Coordinate Owner's keying requirements during the course of the Work.

1.10 WARRANTY

- A. Manufacturer's Warranty: Provide warranty against defects in material and workmanship for period indicated. Complete forms in Owner's name and register with manufacturer.
 - 1. Closers: Fifteen years, minimum.
 - 2. Exit Devices: Five years, minimum.
 - 3. Locksets and Cylinders: Seven years, minimum.
 - 4. Other Hardware: Two years, minimum.

1.11 MAINTENANCE PRODUCTS

- A. Provide special wrenches and tools applicable to each different or special hardware component.
- B. Provide maintenance tools and accessories supplied by hardware component manufacturer.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Manufacturers' catalog numbers are used herein to establish type, series, operation and quality desired; substitutions of approved equal will be permitted only where invited.
- B. Template Hardware: All hardware applied to metal doors or jambs shall be made to template and secured by machine screws. Reinforcing units manufactured by the lock manufacturer shall be furnished for hollow metal doors where cylindrical locks are specified. Furnish templates and reinforcing units to metal door and frame manufacturer unless otherwise requested.
- C. Fastenings: Finish hardware shall be furnished with all necessary screws, bolts or other fastenings of sufficient quantity, suitable size and type for heavy use and long life, and shall harmonize with hardware as to material and finish.
 - 1. Items for application to concrete or masonry shall be furnished with machine screws and expansion shields.
 - 2. Items for application to wood shall be furnished with wood screws.
 - 3. Items for application on gypsum board or plaster shall be furnished with screws of sufficient length to provide solid connection to framing or backing behind gypsum board or plaster.
 - 4. Items applied to mineral and hollow core doors shall be furnished with sex bolts, except as noted otherwise.

5. Phillips head type screws shall be used for exposed screws.
 6. Screws shall be full-threaded. No combination screws are allowed.
- D. All hardware for application to fire doors shall be Underwriter's Laboratory approved and listed, as applies.
- E. Closers shall have following maximum pressure for opening doors.
1. Interior Door: 5 pounds pressure.
 2. Exterior Doors: 8.5 pounds pressure.
 3. Fire Doors: 15 pounds pressure
- F. Substitutions: No substitutions for Best cylinders or Best locks permitted.
- G. Provide competent representative who shall inspect and direct the method of setting, applying and adjusting hardware. It is not required that the representative shall remain constantly at the building, but shall, as representative of the Architect, properly inspect all the work in the application of hardware, as it progresses, both in factory where others are applying same, and at the building. The representative shall be at all times easily accessible to the Architect during execution of the work in order to attend to items as the Architect shall direct.
- H. The Contractor shall verify Architect's details for fitting of hardware.

2.02 DESIGN AND PERFORMANCE CRITERIA

- A. Provide specified door hardware as required to make doors fully functional, compliant with applicable codes, and secure to extent indicated.
- B. Provide individual items of single type, of same model, and by same manufacturer.
- C. Provide door hardware products that comply with the following requirements:
1. Applicable provisions of federal, state, and local codes.
 2. Hardware on Fire-Rated Doors: Listed and classified by UL (DIR), ITS (DIR), or testing firm acceptable to authorities having jurisdiction as suitable for application indicated.

2.03 MANUFACTURERS - BASIS OF DESIGN

- A. Hinges: Hager Hinge Co.; Stanley Hardware, McKinney Mfg. Co; Ives.
- B. Pivots: Rixson; Ives.
- C. Push/Pulls: McKinney Mfg.; Rockwood; Ives; Trimco Builders Brass
- D. Locksets:
1. Cylindrical; Best Access Systems; Basis of Design.
- E. Cylinders: Best Access Systems, "Preferred Peaks Cores (Uncombined)"; No substitutions will be permitted.
- F. Exit Devices: Von Duprin; No substitutions will be permitted.
- G. Closers: LCN Closers; no substitutions will be permitted.
- H. Stop/holders: Rixson; Glynn-Johnson, Rockwood, Ives; McKinney Mfg.
- I. Manual and Automatic Bolts: Door Controls International; McKinney Mfg.; Ives; Rockwood.
- J. Weatherstripping: McKinney Mfg.; National Guard; Pemco Mfg.Co.; Reese Enterprises Inc; Zero International.
- K. Protection Kick Plates: McKinney Mfg.; Rockwood; Trimco Builders Brass; Ives.
- L. Mutes: McKinney Mfg.; Ives; Rockwood.
- M. Threshold: McKinney Mfg.; National Guard; Pemco Mfg.Co.; Reese Enterprises Inc.; Zero International.
- N. Substitutions: See Section 01 2500 - Substitutions.

2.04 LOCKS AND LATCHES

- A. Locks: Provide a lock for every door, unless specifically indicated as not requiring locking.
 - 1. If no hardware set is indicated for a swinging door provide an office lockset.
 - 2. Trim: Provide lever handle or pull trim on outside of all locks unless specifically stated to have no outside trim.
 - 3. Lock Cylinders: Provide key access on outside of all locks unless specifically stated to have no locking or no outside trim.
- B. Lock Cylinders: Manufacturer's standard tumbler type, seven-pin Preferred Peaks Key cores/keyway.
 - 1. Provide cams and/or tailpieces as required for locking devices required.
 - 2. Cores to be turned over to MUHC, uncombined.
- C. Keying: Grand master keyed.
- D. Latches: Provide a latch for every door that is not required to lock, unless specifically indicated "push/pull" or "not required to latch".

2.05 KEYING

- A. Door Locks: Grand master keyed.
 - 1. Include construction keying and control keying.
 - 2. Key to existing keying system.
 - 3. All cores shall be 7 pin type Preferred Peaks Keyway, grand master key.
- B. Supply keys in the following quantities:
 - 1. Contractor to provide two (3) blank keys per lock.
 - 2. Any keys supplied shall be uncut.

2.06 FINISHES

- A. Typical hardware finish shall be brushed chrome (US26D) unless otherwise noted.
- B. Spray paint door closers to match hardware finish.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that doors and frames are ready to receive this work; labeled, fire-rated doors and frames are properly installed, and dimensions are as indicated on shop drawings.
- B. Verify that electric power is available to power operated devices and of correct characteristics.
- C. Doors, door frames and hardware shall be examined for damage, defects, and suitability for intended use. Any part or item found damaged, defective, or inadequate shall be made good before installation, or shall be replaced with good material.

3.02 INSTALLATION

- A. Install hardware in accordance with manufacturer's instructions and applicable codes.
- B. Use templates provided by hardware item manufacturer.
- C. Door Hardware Mounting Heights: Distance from finished floor to center line of hardware item. As indicated in following list; unless noted otherwise in Door Hardware Schedule or on drawings.
 - 1. For Steel Doors and Frames: Install in compliance with DHI (LOCS) recommendations.
 - 2. For Wood Doors: Install in compliance with DHI WDHS.3 recommendations.
 - 3. Fitting: Accurately and properly fit hardware. Securely fasten fixed parts for smooth, trouble-free, non-binding operation; fit faces of mortised parts snug and flush; operating parts shall move freely and smoothly without binding, sticking or excessive clearance.

4. Protect hardware from damage or marring of finish during construction; use strippable coatings, removable tapes or other approved means.
5. Ensure hardware displays no evidence of finish paint after final building clean-up with exception of prime-coated hardware installed for finish painting. The Contractor may achieve this by sequencing installation, removing after fitting and reinstalling after painting is completed, providing protection, cleaning to original hardware finish, or other approved means.
6. Latch and Bolt: Install latch and bolt to automatically engage in keeper, whether activated by closer or by manual push; in no case shall additional manual pressure be required to engage latch or bolt in keeper.
7. Closers:
 - a. Do not mount closers on corridor or vestibule side of door, except at exterior doors.
 - b. Mount closers for 180 degrees swing wherever possible. Supply drop plates at narrow top rail doors.
 - c. Carefully adjust closers to operate noiselessly and evenly.
 - d. Have manufacturer's representative regulate closers prior to the Owner's acceptance of building.
8. Kick Plates/Armor Plates: Install on push side of doors unless otherwise noted.
9. After work has been otherwise completed, examine hardware in place for complete and proper installation. Lubricate bearing surfaces of moving parts and adjust latching and holding devices for proper function; adjust door control devices for speed and power; test keys for proper conformance with keying system.
10. Completely remove protective materials and devices and thoroughly clean exposed surfaces of hardware; check for surface damage prior to final cleaning for the Owner's acceptance of project.

3.03 FIELD QUALITY CONTROL

- A. Provide an Architectural Hardware Consultant (AHC) to inspect installation and certify that hardware and installation has been furnished and installed in accordance with manufacturer's instructions and as specified.

3.04 ADJUSTING

- A. Adjust hardware for smooth operation.

3.05 PROTECTION

- A. Do not permit adjacent work to damage hardware or finish.

3.06 DEFECTIVE WORK

- A. Replace, rework or otherwise make good any hardware found defective as follows:
 1. Unauthorized substitutes.
 2. Items delivered with missing, broken, damaged or defaced parts.
 3. Items of incorrect hand or function.

3.07 HARDWARE GROUPS

- A. The hardware sets listed below represent the design intent and direction of the Owner and Architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the Architect with corrections made prior to the bidding process.
- B. Manufacturer's Abbreviations:
 1. IV - Ives
 2. HA - Hager
 3. BO - Bosch
 4. ES - Essex Industries

5. MK - Mckinney
6. PE - Pemko
7. RF - Rixson
8. RO - Rockwood
9. BE - Stanley Security Solutions Inc (BE)
10. FO - Folger Adam
11. HS - HES
12. GJ - Glynn-Johnson
13. LC - LCN Closers
14. SU - Securitron

SET #1

Doors: 1224

Hinge	By Demountable Partition Vendor		
1 Privacy	9K30L 14D S3	626	BE
1 Surface Overhead Stop	9-X36	630	RF

Note: Coordinate Lockset with demountable partition door thickness.

SET #2

Doors: 1225

3 Hinge	TA2714 4-1/2" X 4-1/2"	US26D	MK
1 Privacy	9K30L 14D S3	626	BE
1 Wall Stop	409	US32D	RO
3 Silencer	608	Grey	RO

SET #3

Doors: 1226

3 Hinge	TA2314 4-1/2" X 4-1/2"	US32D	MK
1 Privacy	9K30L 14D S3	626	BE
1 Door Closer	4040XP REG	AL	LC
1 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
1 Wall Stop	409	US32D	RO
3 Silencer	608	Grey	RO

SET #4

Doors: 1227-1

3 Hinge (heavy weight)	T4A3786 NRP 5" X 4-1/2"	US26D	MK
1 Storeroom Lockset	9K37D 14D 53	US26D	BE
1 Electrical Strike	1006	630	
1 Electrical Strike Face Plate	J	US32D	RO
1 SMART Pac Bridge Rectifier	2005M3		
1 Magnetic Hold Open	990M	689	RF
1 Closer	4040XP REG	ALUM	LC
1 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
3 Silencer	608		RO
1 Position Switch	DPS-W-BK (VERIFY COLOR)		SU

1 Power Supply	BPS-24-1		SU
1 Battery Backup	B-24-5		SU

Notes: Card reader on corridor side. Operation: A valid card presentation releases electronic strike plate to open doors for authorized entry. During normal working hours, door is open and held open with magnetic hold open, tied to fire alarm. Inside handle for egress. Door position switch monitors door open/closed status to the access control system. Fail safe.

SET #5

Doors: 1227-2

3 Hinge (heavy weight)	T4A3786 NRP 5" X 4-1/2"	US26D	MK
1 Passage Set	9K37L 14D S3	626	BE
1 Kick Plate	K1050 1-" X 2" LDW 4BE CSK	US32D	RO
1 Wall Stop	409	US32D	RO
3 Silencer	608	Grey	RO

Notes: Automatic operators by other. Operation: Turn of handle and pull to initiate power assist auto operator. Free egress at all times.

SET #6

Doors: 1228

3 Hinge (heavy weight)	T4A3786 NRP 5" X 4-1/2"	US26D	MK
3 Hinge	TA2714 4-1/2" X 4-1/2"	US26D	MK
2 Set Manual Flush Bolts (T&B)	557	US32D	RO
1 Dust Proof Strike	570	US32D	RO
1 Magnetic Lock (Active Leaf)	M62BD		SU
1 Push Plate	70F	US32D	RO
1 Pull Plate	BF 111X70C	US32D	RO
1 Wall Stop	409	US32D	RO
3 Silencer	608	Grey	RO
1 Position Switch	DPS-W-BK	Light Grey	SU
1 Motion Sensor	XMS		SU
1 Power Supply	BPS-24-1		SU
1 Battery Backup	B-24-5		SU

Notes: Automatic Operator by other. Remote release and camera by other. Operation: Remote release releases magnetic lock then opens door with auto operator for authorized entry. Can always open door from Zone 2 to get back into Zone 1. Door position switch monitors door open/closed status to the access control system. Fail safe.

SET #7

Doors: 1237

1 Continuous Swing Clear Hinge	HG326	630	MR
1 Storeroom Lockset	9K37D 14D S3	626	BE
1 Door Closer	4040XP REG	AL	LC
1 Kick Plate	K1050 10" X 2" LDW 4BE CSK	US32D	RO
1 Wall Stop	409	US32D	RO
3 Silencer	608	Grey	RO

SET #8

Doors: 1238-1

Lock Core

US26D BE

* Remainder of door hardware by RF Shielding Vendor.

SET #9

Doors: 1231

* DOOR ASSEMBLY AND HARDWARE BY SLIDING DOOR MANUFACTURER
(FROM SALVAGE).

SET #10

Doors: 1232

1 Door Position Switch

DPS-W-BK (Light Grey)

SU

1 Lock Core

US26D BE

* Remainder of door hardware by Automatic Door Vendor.

Notes: Auto Operator by Automatic Door Vendor. Card reader and remote release and camera by other. Operations: Remote releases lockset then open door with auto operator for authorized entrance. Zone 3 wave plate to exit. Manual sliding bifold door to be open to allow for patient bed/stretchers access to Zone 3. Door position switch monitors door open/closed status to the access control system. Fail safe.

END OF SECTION 08 7100

SECTION 08 8000
GLAZING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Interior glazing.
- B. Miscellaneous Glazing.
- C. Glazing compounds.

1.02 RELATED REQUIREMENTS

- A. Section 07 9200 - Joint Sealants: Sealants for other than glazing purposes.
- B. Section 08 1416 - Flush Wood Doors: Glazed lites in doors.
- C. Section 08 4229.23 - Sliding Automatic Entrances: Glazing in aluminum sliding door units.
- D. Section 08 4243 - Intensive Care Unit / Critical Care Unit Entrances: Glazing in aluminum sliding door units.
- E. Section 13 4942 - Modular RF/EM Shielded Rooms: RF shielded control window.

1.03 REFERENCE STANDARDS

- A. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials; current edition.
- B. ANSI Z97.1 - American National Standard for Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test; 2015 (Reaffirmed 2020).
- C. 11
- D. 11
- E. ASTM C794 - Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants; 2018 (Reapproved 2022).
- F. ASTM C864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers; 2005 (Reapproved 2019).
- G. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018.
- H. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials; Current Edition.
- I. ASTM C1036 - Standard Specification for Flat Glass; 2021.
- J. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass; 2018.
- K. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2016.
- L. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- M. ASTM E1300 - Standard Practice for Determining Load Resistance of Glass in Buildings; 2016.
- N. ASTM E2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation; 2019.
- O. GANA (GM) - GANA Glazing Manual; Glass Association of North America; 2009.
- P. GANA (SM) - GANA Sealant Manual; 2008.
- Q. ICC (IBC) - International Building Code; 2009.
- R. IGMA TM-3000 - North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial & Residential Use; 1990 (2016).
- S. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; 2022.

- T. UL 10B - Standard for Fire Tests of Door Assemblies; Current Edition, Including All Revisions.
- U. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies; Current Edition, Including All Revisions.
- V. UL 263 - Standard for Fire Tests of Building Construction and Materials; Current Edition, Including All Revisions.

1.04 PERFORMANCE REQUIREMENTS

- A. General Requirements:
 - 1. All glass and glazing shall meet requirements of International Building Code, 2009.
- B. Allowable Tolerances:
 - 1. Bow or Warp: As measured with glass resting on edge upon two 1 inch wide supports.
 - a. Typical: Maximum bow or warp permitted in light shall not exceed 1/8 inch in 48 inches.
 - b. Tempered Glass: Bow or warp shall not exceed tolerances as stated in Fed. Spec. DD-G-1403C.
- C. System Performance Requirements:
 - 1. General: Provide glazing systems that are produced, fabricated, and installed to withstand normal thermal movement, wind loading, and impact loading (where applicable), without failure including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; and other defects in construction.
 - 2. Normal thermal movement results from the following maximum change members and glazing components. Base engineering calculations on materials' actual surface temperatures due to both solar heat gain and nighttime sky heat loss.
 - a. Temperature Change (Range): 120 degrees F, to minus 5 degrees F, ambient; 180 degrees F., material surface.
- D. Fire Protective Rated Glass: Each lite shall bear permanent, nonremovable label of UL certifying it for use in tested and rated fire protective assemblies.
- E. Fire Protective Glazing Products for Door Assemblies: Products identical to those tested per ASTM E2074 and UL 10B, labeled and listed by UL.

1.05 SUBMITTALS

- A. See Special Conditions - Submittals, for submittal procedures.
- B. Product Data on Glazing Unit Glazing Types: Provide structural, physical and environmental characteristics, size limitations, special handling and installation requirements.
- C. Samples: Submit two samples 12 by 12 inch (305 by 305 mm) in size of glass and plastic units, showing coloration and design.
- D. Manufacturer's Certificate: Certify that glass meets or exceeds specified requirements.
- E. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

- A. Source Limitations for Glass: Obtain the following through one source from a single manufacturer for each glass type: clear float glass, coated float glass, and insulating glass.
- B. Source Limitations for Glazing Accessories: Obtain glazing accessories through one source from a single manufacturer for each product and installation method indicated.
- C. Perform Work in accordance with GANA Glazing Manual, FGMA Sealant Manual, and SIGMA TM-3000 Glazing Guidelines for glazing installation methods.

- D. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience; or approved by manufacturer.
- E. Glazing for Fire-Rated Door and Window Assemblies: Glazing for assemblies that comply with NFPA 80 and that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing accordance to NFPA 257.
- F. Safety Glazing Products: Comply with testing requirements in 16 CFR 1201 and for wired glass ANSI Z97.1.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Do not install glazing when ambient temperature is less than 50 degrees F (10 degrees C).
- B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials according to manufacturer's written instructions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

1.09 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 liquid glazing sealants when ambient and substrate temperature conditions are outside limits permitted by glazing sealant manufacturer or below 40 degree F.

PART 2 PRODUCTS

2.01 FLAT GLASS MATERIALS

- A. Manufacturers:
 - 1. Pilkington Building Products North America: www.pilkington.com (Basis of Design).
 - 2. Guardian Industries Corporation: www.guardian.com.
 - 3. Visteon Glass Systems: www.visteon.com/floatglass.
 - 4. PPG Glass Technology.
 - 5. Substitutions: See Section 01 2500 - Substitutions.
- B. Clear Float Glass (Type 1): Clear, fully tempered.
 - 1. Annealed Type: ASTM C1036, Type I - Transparent Flat, Class 1 - Clear, Quality-Q3.
 - 2. 1/4 inch (6 mm) minimum thickness for all interior glazing except modular plastic laminate casework.
 - 3. Heat-Strengthened and Fully Tempered Types: ASTM C1048, Kind HS and FT.

2.02 GLAZING SEALANTS

- A. Manufacturers:
 - 1. Dow Corning Corp: www.dowcorning.com.
 - 2. GE Plastics: www.geplastics.com.
 - 3. Pecora Corporation: www.pecora.com.
 - 4. Substitutions: See Section 01 2500 - Substitutions.

2.03 GLAZING ACCESSORIES

- A. Manufacturers:
 - 1. Norton Performance Plastics Corp.
 - 2. Pecora Corporation: www.pecora.com.

3. Tremco, Inc: www.tremcosealants.com.
4. Substitutions: Refer to Section 01 2500 - Substitutions.
- B. Setting Blocks: Neoprene, 80 to 90 Shore A durometer hardness; ASTM C864 Option II. Length of 0.1 inch for each square foot (25 mm for each square meter) of glazing or minimum 4 inch (100 mm) x width of glazing rabbet space minus 1/16 inch (1.5 mm) x height to suit glazing method and pane weight and area.
- C. Spacer Shims: Neoprene, 50 to 60 Shore A durometer hardness, ASTM C 864 Option I. Minimum 3 inch (75 mm) long x one half the height of the glazing stop x thickness to suit application.
- D. Glazing Tape: Preformed butyl compound; 10 to 15 Shore A durometer hardness; coiled on release paper; black color.
- E. Glazing Gaskets: Resilient silicone extruded shape to suit glazing channel retaining slot; ASTM C864 Option II; black color.
- F. Glazing Clips: Manufacturer's standard type.

2.04 SOURCE QUALITY CONTROL

- A. Test samples in accordance with ANSI Z97.1, ASTM E546, and ASTM E576.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that openings for glazing are correctly sized and within tolerance.
- B. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement, weeps are clear, and ready to receive glazing.

3.02 PREPARATION

- A. Clean contact surfaces with solvent and wipe dry.
- B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.
- C. Prime surfaces scheduled to receive sealant.
- D. Install sealants in accordance with 1 and GANA Sealant Manual.
- E. Install sealants in accordance with manufacturer's instructions.

3.03 GLAZING

- A. General Requirements:
 1. Meet requirements of FGMA and reviewed Shop Drawings.
 2. Cut and set glass to full fit and play consistent with expansion and contraction requirements and for absolute security under maximum high velocity wind or vacuum stresses.
 3. Maintain edge clearance at least equal to glass thickness from perimeter of glass to inside of rabbet.
 4. Maintain minimum 1/8 inch clearance between faces of glass and adjacent stop or bead.
 5. Provide setting blocks at sill to transmit windloads from glass to sash. Provide shims at head and jambs at shop-glazed units.
 6. Accurately size and cut clean for each glazing condition. Do not nip edges.
- B. Glazing of Interior Pressed Metal Frames: Use pressure tape and sealant as noted to eliminate rattle and reduce sound transmission.
- C. Sealant Application:
 1. Neatly tool sealant or compound joints to compress material and improve adhesion. Repair air pockets exposed by tooling.
 2. Meet requirements of Sealants Section unless otherwise noted.

3. Ensure removal of protective coatings from aluminum surfaces.
- D. Adhesive Application:
 1. Prepare glass surfaces to be sealant-joined , and apply adhesive in accordance with approved manufacturer's recommendation.
 2. Miter glass where noted.
 3. Apply protective tape to glass edges if recommended by glass manufacturer.
- E. Install fire rated glazing in vision panels in fire-rated doors to requirements of NFPA 80.
- F. Install so that appropriate (UL) markings remain permanently visible.
- G. Insulating Glass:
 1. Install in accordance with glass manufacturer's recommendations.
 2. Temporarily clamp glass during cure of structural silicone. After sufficient cure, remove clamps and fill all gaps with sealant. Remove masking after tooling sealant.

3.04 INSTALLATION - EXTERIOR/INTERIOR DRY METHOD (GASKET GLAZING)

- A. Place setting blocks at 1/4 points with edge block no more than 6 inches (150 mm) from corners within existing window framing.
- B. Rest glazing on setting blocks and push against fixed stop with sufficient pressure on gasket to attain full contact.
- C. Reinstall existing removable stops without displacing glazing gasket; exert pressure for full continuous contact.

3.05 PROTECTION

- A. Protect installed glass against breakage, damage from plaster, sandblasting, welding spatter, or other sources.
- B. Protect coated surfaces in accordance with approved manufacturer's recommendations.

3.06 ADJUSTMENT AND CLEANING

- A. Remove labels, paint spots, and other defacements such that work is clean for the Owner's final acceptance.

END OF SECTION 08 8000

SECTION 09 2116
GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Gypsum wallboard.
- B. Joint treatment, trims and accessories.
- C. Grouting for steel frames.

1.02 RELATED REQUIREMENTS

- A. Section 05 4000 - Cold-Formed Metal Framing.
- B. Section 06 1000 - Rough Carpentry: Wood blocking product and execution requirements.
- C. Section 08 3100 - Access Doors and Panels: Coordination.
- D. Section 09 2216 - Non-Structural Metal Framing.
- E. Section 09 5300 - Acoustical Insulation.

1.03 REFERENCE STANDARDS

- A. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board; 2017 (Reapproved 2022).
- B. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2020.
- C. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board; 2020.
- D. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness; 2022.
- E. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs; 2022.
- F. ASTM C1047 - Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base; 2019.
- G. ASTM C1178/C1178M - Standard Specification for Coated Glass Mat Water-Resistant Gypsum Backing Panel; 2018.
- H. ASTM C1278/C1278M - Standard Specification for Fiber-Reinforced Gypsum Panel; 2017.
- I. ASTM C1396/C1396M - Standard Specification for Gypsum Board; 2017.
- J. ASTM C1629/C1629M - Standard Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels; 2015.
- K. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- L. GA-214 - Levels of Finish for Gypsum Panel Products; 2021.
- M. GA-216 - Application and Finishing of Gypsum Panel Products; 2021.
- N. GA-600 - Fire Resistance and Sound Control Design Manual; 2021.
- O. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- P. ICC-ES AC308 - Acceptance Criteria for Water-Resistive Barriers; ICC Evaluation Service, Inc.; 2013.
- Q. UL (FRD) - Fire Resistance Directory; Current Edition.

1.04 SUBMITTALS

- A. See Special Conditions - Submittals, for submittal procedures.
- B. Product Data: Provide data on gypsum board, accessories, and joint finishing system.

1.05 QUALITY ASSURANCE

- A. Perform in accordance with ASTM C 840. Comply with requirements of GA-600 for fire-rated assemblies.
- B. Design Criteria: Fire-rated gypsum wallboard systems shall satisfy minimum fire ratings as noted.
- C. Requirements of Regulatory Agencies: Fire-rated gypsum wallboard systems shall meet requirements of the State Fire Marshal and local Building Inspector.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in original packages, containers or bundles, bearing brand name and name of manufacturer or supplier for whom product is manufactured.
- B. Keep materials dry, preferably by storing inside building or under roof. Where necessary to store gypsum board outside, stack off ground on properly supported level platform, and fully protect from weather.
- C. Stack gypsum board neatly and flat, with care to avoid damage to edges, ends, and surfaces.

1.07 JOB CONDITIONS

- A. Environmental Requirements: Maintain areas to receive gypsum board at uniform temperature between 55 and 75 degrees Fahrenheit during gypsum board application and joint finishing. Provide adequate ventilation to eliminate excessive moisture within building during this period.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Gypsum Board:
 - 1. G-P Gypsum Corporation: www.gp.com.
 - 2. National Gypsum Company: www.nationalgypsum.com.
 - 3. USG Corporation: www.usg.com.
 - 4. Georgia Pacific Corp.
 - 5. Substitutions: See Section 01 6000 - Substitutions.

2.02 GYPSUM BOARD MATERIALS

- A. Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
 - 1. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 - a. Mold-resistant board is required whenever board is being installed before the building is enclosed and conditioned.
 - b. Mold resistant board is required at moisture resistant board / exterior sheathing board.
- B. Fire Rated Gypsum Wallboard: ASTM C36; Type X, UL rated; sizes to minimize joints in place; ends square cut.
 - 1. Thickness: 5/8 inch (16 mm).
 - 2. Edges: Tapered.
 - 3. Use throughout unless otherwise noted.
- C. Moisture-Resistant Gypsum Backing Board: ASTM C 630/C 630M; ends square cut.
 - 1. Thickness: 5/8 inch (16 mm) unless otherwise noted.
 - 2. Edges: Tapered.

3. Use throughout in Equipment Room, sink alcoves, behind sinks and in restrooms not receiving tile wainscoat.
- D. Moisture Resistant Tile Backing Board: Fiberglass - Mat Faced Gypsum Backing Board; ASTM C1178, Type 'X':
 1. Application: Surfaces behind tile on restroom walls unless otherwise noted.
 2. Thickness: 5/8 inch.
 3. Width: 4 feet.
 4. Length: 8 feet.
 5. Weight: 2.5 lb/sq. ft.
 6. Edges: Square.
 7. Surfacing: Coated fiberglass mat on face, back, and long edges.
 8. Mold Resistance (ASTM D3273): Not less than 10, in a test as manufactured.
 9. Microbial Resistance (ASTM D6329, EPA 12-week protocol): Will not support microbial growth.
 10. Permeance (ASTM E96): Not more than 1.0 perms when tiled.
 11. Products:
 - a. Georgia Pacific Gypsum "Dens Shield FireGuard Tile Backer"; CertainTeed's "GlasRoc Tile Backer - Type X," or approved equal.
 - b. Substitutions: See Section 01 2500 - Substitutions.
- E. Impact Rated Wallboard: Tested to Level 3 soft-body and hard-body impact in accordance with ASTM C 1629.
 1. Application: On corridor walls and in holding bays.
 2. Mold Resistance: Score of 10, when tested in accordance with ASTM D 3273.
 3. Paper-Faced Type: Gypsum wallboard as defined in ASTM C 1396/C 1396M.
 4. Type: Fire-resistance rated Type X, UL or WH listed.
 5. Thickness: 5/8 inch (16 mm).
 6. Edges: Tapered.
 7. Products:
 - a. National Gypsum Company; Gold Bond Hi-Impact Brand XP Wallboard.
 - b. USG Corporation; Fiberock Brand Panels - VHI Abuse-Resistant.
 - c. Substitutions: See Section 01 6000 - Product Requirements.

2.03 GYPSUM BOARD ACCESSORIES

- A. Acoustic Insulation: As specified in Section 09 5300.
- B. Acoustic Sealant: Acrylic emulsion latex or water-based elastomeric sealant; do not use solvent-based non-curing butyl sealant.
- C. Screws: ASTM C1002, self-drilling and self-tapping steel screws with double-lead thread design as approved by system manufacturer for standard and heavier gauge load bearing steel frame.
- D. Metal Accessories: Electro-galvanized steel corner beads, trim, control joint beads, and edge beads formed for concealment of flanges in joint cement and manufactured specifically for gypsum wallboard construction. Provide in single pieces.
- E. Joint Reinforcing Tape and Cement: ASTM C475. Use glass-fiber open-weave tape.
- F. Adhesive for Laminating Board: Contact cement as recommended by approved board manufacturer.
- G. Acoustical Caulking: Permanently resilient, nonstaining type of density equal to or greater than gypsum board. Same as The Tremco Mfg. Co.'s "Tremco Acoustical Sealant"; Pecora Corp.'s "BA-98 Acoustical Sealant"; Presstite Products Inmont Corp's "579.64 Acoustical Sealer"; or approved equal.

- H. Edge Sealer for Moisture-Resistant Board: Thinned water-based ceramic tile mastic or waterproof flexible sealant as recommended by manufacturer for sealing edges and sealing openings.
- I. Control Joints:
 - 1. Control Joints to be provided as noted on the drawings and as delineated in this specification. Verify intentional placement of control joints with Architect.
 - 2. Same as USG's Control Joint No. 093, taped-in control joint with removable plastic tape.
- J. Trim: ASTM C 840; Bead type.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Inspect areas and surfaces scheduled to receive gypsum board and verify that:
 - 1. Support systems are in proper alignment.
 - 2. Blocking, bracing, and backing members of support systems are installed.
- B. Do not start installation until unsatisfactory conditions have been corrected.
- C. Do not start installation until unsatisfactory conditions have been corrected.
- D. Use water-resistant gypsum board at all west area locations including all walls in toilet rooms and janitor closets and equipment rooms.
- E. Verify that project conditions are appropriate for work of this section to commence.

3.02 ACOUSTIC ACCESSORIES INSTALLATION

- A. Acoustic Sealant: Install in accordance with manufacturer's instructions.
 - 1. Place two beads continuously on substrate before installation of perimeter framing members.
 - 2. Place continuous bead at perimeter of each layer of gypsum board.
 - 3. Seal around all penetrations by conduit, pipe, ducts, and rough-in boxes.

3.03 GYPSUM BOARD INSTALLATION

- A. Comply with ASTM C 840, GA-216, and manufacturer's instructions.
- B. Cut gypsum board by scoring and breaking or sawing from face side. Smooth cut edges and ends of gypsum board as necessary in order to obtain neat jointing.
- C. When gypsum board is applied to both ceiling and walls, apply the gypsum board first to ceiling and then to walls.
- D. Scribe ceiling board neatly in casing bead where it meets surfaces of different materials in other planes.
- E. Apply in either vertical or horizontal direction with ends and edges falling on studs, except where edge joints are at right angles to stud. Gypsum wallboard shall be of length required to reach full height of vertical surfaces in one continuous piece. Bring ends and edges into contact with adjoining board.
- F. Maximum allowable gap at end joints: ¼ inch.
- G. Lay out joints at openings so that no end joint aligns with edges of opening. Stagger end joints and arrange joints on opposite sides of partition to occur on different studs. At external corners, butt and fit base to provide solid edge. At end joints between framing members, Taper and back-block or apply metal-backed tape.
- H. Hold gypsum board nominal ¼ inch above floor or curb unless otherwise noted.
- I. Where gypsum board is carried full height from floor to underside of overhead structure system, provide for deflection of structure by undercutting board nominal 3/8 inch. Caulk top edge of board to structure in continuous bead to form elastic closure where specifically noted.

- J. Cut board to fit electrical outlets, pipes or other items as required. Cut gypsum board by scoring on face and back in outline before removal or by cutting with a saw or other suitable tool. Smooth all cut outs where necessary.
- K. Provide gypsum backer board gusset at double stud walls where studs are less than 3-5/8 inches thick.
- L. Fastening: Application of fasteners shall proceed from center or field to edges and ends, pressing firmly against supports. Space fasteners when used at edges or ends, not more than one inch from edges and not less than 3/8 inch from edges and ends of gypsum board. Fasteners shall be slightly below surface, without breaking the surface paper of gypsum wallboard or stripping the framing member around the screw shank. Perimeter fastening into the partition plate or sole at the top and bottom is not required except where fire ratings or structural performance require such fastening.
- M. Single-Layer Non-Rated: Install gypsum board in most economical direction, with ends and edges occurring over firm bearing.
- N. Single-Layer Fire-Rated: Install gypsum board vertically, with edges and ends occurring over firm bearing.
- O. Double-Layer Installation: Use gypsum backing board for first layer, placed perpendicular to framing or furring members. Place second layer perpendicular to first layer. Offset joints of second layer from joints of first layer.
- P. Moisture Protection: Treat cut edges and holes in moisture resistant gypsum board with sealant.

3.04 INSTALLATION OF TRIM AND ACCESSORIES

- A. Control Joints: Place control joints as indicated on the Contract Documents consistent with lines of building spaces and, unless noted otherwise, as follows:
 - 1. Not more than 30 feet (10 meters) apart on walls and ceilings over 20 feet (6.1 meters) long. Contractor to coordinate locations with Architect prior to installation.
 - 2. At exterior soffits, not more than 20 feet (6.1 meters) apart in both directions.
- B. Corner Beads: Install at external corners, using longest practical lengths.
- C. Edge Trim: Install metal trim at exposed edges of gypsum board and locations where gypsum board abuts dissimilar materials and as indicated.

3.05 JOINT TREATMENT

- A. Finish all gypsum board in accordance with GA-214 Level 4.
- B. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
 - 1. Feather coats of joint compound so that camber is maximum 1/32 inch (0.8 mm).
- C. Fire Rated Conditions:
 - 1. Preserve continuity of fire rating.
 - 2. Provide fire rated enclosures for electrical outlets and junction boxes, recessed cabinets, recessed light fixtures, and other items of any nature.
 - 3. Where adjacent interior spaces have suspended ceilings of different heights, extend separating partition finish on both faces of studs to at least three inches above higher ceiling finish.
 - 4. Meet requirements of applicable codes and authorities for taping and cementing joints and fastener heads.
- D. Water Resistant Board: Cut on job site before erecting board.

3.06 CLEANING AND ADJUSTING

- A. Remedy evidence of fastener popping or ridging.

- B. Fill and finish joints and corners of cementitious backing board as recommended by manufacturer.

3.07 TOLERANCES

- A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet (3 mm in 3 m) in any direction.

3.08 FINISH LEVEL SCHEDULE

- A. Level 1: Above finished ceilings concealed from view.
- B. Level 4: Walls and ceilings scheduled to receive flat or eggshell paint finish.

END OF SECTION 09 2116

SECTION 09 2216
NON-STRUCTURAL METAL FRAMING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Metal studs, furring and suspension systems for the support of gypsum wall board, walls, ceilings, and soffits.
- B. Steel studs for framing at magnetic shielding and other locations detailed with heavier gauge studwork.
- C. Backing plates for items adjoining or fastening to these systems unless otherwise noted, including backing for mechanical and electrical items.
- D. Miscellaneous metal items for attaching stud framing to structure.
- E. Channel reinforcement at glazed frames.
- F. Framing accessories.

1.02 RELATED REQUIREMENTS

- A. Section 05 4000 - Cold-Formed Metal Framing: Heavy gauge metal framing at magnetic panels.
- B. Section 05 5000 - Metal Fabrications: Metal fabrications attached to stud framing.
- C. Section 06 1000 - Rough Carpentry: Wood blocking within stud framing.
- D. Section 08 3100 - Access Doors and Panels.
- E. Section 09 2116 - Gypsum Board Assemblies.
- F. Section 09 5300 - Acoustical Insulation.

1.03 REFERENCE STANDARDS

- A. AISI S100-12 - North American Specification for the Design of Cold-Formed Steel Structural Members; 2012.
- B. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength; 2021.
- C. ASTM A568/A568M - Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for; 2019a.
- D. ASTM A641/A641M - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire; 2019.
- E. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.
- F.
- G. ASTM C645 - Standard Specification for Nonstructural Steel Framing Members; 2018.
- H. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2020.
- I. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs; 2022.
- J. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2009 (Reapproved 2016).
- K. ASTM E413 - Classification for Rating Sound Insulation; 2022.
- L. SSPC-Paint 20 - Zinc-Rich Coating (Type I - Inorganic, and Type II - Organic); 2019.

1.04 SUBMITTALS

- A. See Special Conditions - Submittals, for submittal procedures.
- B. Product Data: Provide data describing framing member materials and finish, product criteria, load charts, limitations, and manufacturer's data on partition head to structure connectors, showing compliance with requirements.
- C. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.

1.05 QUALITY ASSURANCE

- A. Perform Work in accordance with ASTM C 754.
 - 1. Maintain one copy on site.

1.06 PROJECT CONDITIONS

- A. Coordinate the placement of components to be installed within stud framing system.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Marino / Ware.
- B. Clark / Dietrich Industries, Inc.
- C. SuperStud Building Products, Inc.

2.02 FRAMING MATERIALS

- A. Metal Studs: Conform to types and sizes as noted on the drawings.
 - 1. 20 Gauge C Studs: C-shaped sections roll formed with punched webs and with plain or perforated flanges to receive screws; fabricated from hot dipped galvanized steel meeting requirements of ASTM A568 with G-60 galvanized coating in accordance with ASTM A653, Grade A, G-60 coating. Same as Clark / Dietrich Industries' "Pro Stud Framing System"; or approved equal.
- B. Steel Studs: Conform to types and sizes as noted on the drawings.
 - 1. 18 or 16 Gauge C Studs: C-shaped sections roll formed with punched webs and with stiffened flanges; fabricated from hot dipped galvanized steel meeting requirements of ASTM A568-98 with a minimum yield point of 50,000 p.s.i., and with a G-60 galvanized coating in accordance with ASTM A653, Grade D, G-60 coating. Same as Clark / Dietrich Industries' "Pro Stud Framing System"; or approved equal.
- C. Runner Tracks:
 - 1. Formed from 20 gauge hot dipped galvanized steel meeting requirements of ASTM 653, Grade A.
- D. Channels:
 - 1. Typical for Framing, Furring, and Carrying Channels: Cold-rolled steel coated with rust-inhibitive material, with following minimum weights per 1000 lineal feet, subject to standard mill weight tolerances:
 - a. 3/4 Inches, 16 Gauge, 300 Pounds.
 - b. 1-1/2 Inches, 16 Gauge, 475 Pounds.
 - c. 2 Inches, 16 Gauge, 590 Pounds.
 - 2. Furring (Hat) Channels, Screw-On Type: 7/8 inch formed from 20 gauge galvanized steel with either plain or perforated flanges to receive screws.
- E. Partition Stiffeners or bridging: Cold-rolled channel or stud manufacturer's standard bridging for approved stud.

- F. Typical Backing Plates: 16 gauge unpunched studs, flat plates, and bent plates, profile as shown.
- G. Channel Reinforcement at Glazed Partition Frames: Ten gauge cold-rolled steel channel with 2-1/2 inch legs and widths as noted; coat with rust inhibitive material.
- H. Miscellaneous Metal Items: Meet requirements of Metal Fabrications Section.
 - 1. Compression Strut: Angles and channels as noted.
 - 2. Supports for Partition, Soffits, Bulkheads, and Recessed Items Above Ceiling: Rods, couplings, and bolts as required to properly support overhead construction.
- I. Fasteners:
 - 1. Powder Driven Fasteners: Tempered steel pins, minimum 0.145 inch diameter with special corrosive-resistant plating or coating. Pins shall have guide washers to accurately control penetration, minimum 1-1/4 inches unless otherwise noted. Fastening shall be accomplished by low-velocity piston-driven powder-actuated tools. Pins and tool shall be same as manufactured by Hilti Fastening Systems; Impex Tool Corp.; or approved equal.
 - 2. Sheet Metal Screws: Self-drilling and self-tapping, No. 10 pan head. Same as Buildex's "TEKS Fasteners"; The Rawlplug Co., Inc.'s "Rawl Self-Drilling Screws"; United States Gypsum Co.'s "USB Screws, Type S-12 Pan Head"; or approved equal.
 - 3. Concrete Screws: Heat treated screws with unique Hi-Lo thread design that cuts threads in pre-drilled holes in concrete. Same as Buildex's "Tapcon Anchors"; The Rawlplug Co., Inc.'s "Tapcon Fasteners"; United States Gypsum Co.'s "HWH Tapcon Anchors"; or approved equal.
 - 4. Expansion Anchors: Fed. Spec. FF-S-325, Group II, Type 4, size as noted. Same as Hilti Fastening Systems "Kwik-Bolt II Concrete Expansion Anchors and Hilti Drop-In Anchors"; Wej-It Expansion Products, Inc.'s "Wej-It Concrete Anchors and Wej-It Drop-In Anchors"; or approved equal.
 - 5. Machine Bolts, Nuts, and Washers: Low carbon steel standard fasteners, externally and internally threaded, ASTM A307, malleable washers.
- J. Hanger, Bracing and Tie Wires: Fed. Spec. QQ-W-461H, Finish 5, Class 1, soft temper or ASTM A641, Class 1 coating, soft temper. Minimum gauges: Hangers, 8; Diagonal bracing wire, 12; Single-strand tie wire, 16' Double-strand tie wire, 18.
- K. Loadbearing Studs: As specified in Section 05 4000.
- L. Ceiling Hangers: Type and size as specified in ASTM C754 for spacing required.
- M. Partition Head to Structure Connections: Provide mechanical anchorage devices that accommodate deflection using slotted holes, screws and anti-friction bushings, preventing rotation of studs while maintaining structural performance of partition.
 - 1. Structural Performance: Maintain lateral load resistance and vertical movement capacity required by applicable code, when evaluated in accordance with AISI S100-12.
 - 2. Material: 1 steel sheet, SS Grade 50, with G60/Z180 hot dipped galvanized coating.
 - 3. Provide components UL-listed for use in UL-listed fire-rated head of partition joint systems indicated on drawings and specified in Section 07840.
 - 4. Provide top track preassembled with connection devices spaced to fit stud spacing indicated on drawings; minimum track length of 12 feet (3660 mm).
 - 5. Acceptable Products: Fast Clip (TM) Slide Clip and SLP-TRK (TM) Slip Track manufactured by Dietrich Industries, Inc.; Verticlip (TM) and Driftclip (TM) and manufactured by The Steel Network, Inc., or approved equal.
- N. Acoustic Insulation: As specified in Section 09 5300.
- O. Acoustic Sealant: As specified in Section 09 2116.

PART 3 EXECUTION

3.01 PREPARATION

- A. Coordinate details and requirements of other work which adjoins or fastens to metal studs or furring and requires backing or special support framing included in this Section.
 - 1. Items requiring backing or support include, but are not necessarily limited to, casework, wall-mounted finish hardware, miscellaneous specialties, handrail brackets, mechanical equipment, electrical panels, and electrical equipment, and similar items.
 - 2. Obtain the Architect's approval of backing method proposed to satisfy requirements of this Section which differs from methods noted or shown.

3.02 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that rough-in utilities are in proper location.

3.03 INSTALLATION

- A.
- B. Extend partition framing to structure where indicated and to six (6) inches above ceiling in other locations where indicated.
- C. Partitions Terminating at Structure: Attach extended leg top runner to structure, maintain clearance between top of studs and structure, and brace both flanges of studs as indicated.
- D. General Requirements:
 - 1. Securely fasten framing members together and to walls, floors, and other structural supports.
 - 2. Drop-In Expansion Anchors: Use for floor installation only. NOT permitted for use in overhead or vertical surfaces.
 - 3. Wire-Tying:
 - a. For splices, use double-wrap tie.
 - b. For tying horizontal channels placed at intersecting legs or channel brackets, use figure 8 tie.
 - c. For tying members perpendicular to each other, use saddle tie.
 - d. Wrap vertical hanger wires minimum three tight turns within a distance of 1-1/2 inches and four tight turns within a distance of 1-1/2 inches for diagonal bracing wires.
 - 4. Wires for Suspended Ceilings and Partition Bracing: Provide as required for proper support.
 - 5. Cut Studs: If stud web is cut more than 50 percent or stud flange is cut to any degree, restore stud to original strength to the Architect's satisfaction by welding, screwing or wire-tying on steel reinforcement.
- E. Stud Partition, Typical:
 - 1. Runner Track:
 - a. Use same runner track type and stud type for partitions unless otherwise noted.
 - b. Accurately align floor and ceiling runner track and securely attach at maximum 24 inches on center and at each end.
 - c. Do not miter runner track at corners.
 - 2. Studs:
 - a. Space studs maximum 16 inches on center unless otherwise noted.
 - b. Space studs maximum 16 inches on center at lead lined partitions.
 - c. Locate studs maximum two inches from opening jambs abutting partitions or other construction.

- d. At partition corners, position stud to form outside corner and locate another stud within two inches from inside corner along each partition, unless otherwise noted.
 3. Completely frame openings.
 4. Where partitions are unsupported laterally for 20 feet or more, use heavier gauge runner track at top of steel studs and secure by stiffening and bracing to structure above.
 5. Vertical Framing Openings:
 - a. Refer to architectural drawings for framing notes. Provide 20 gauge studs at all jambs.
 6. Framing over Openings:
 - a. Refer to architectural drawings for framing notes. Weld, bolt, or screw jamb frame anchors to studs. Provide 20 gauge studs at heads and sills.
 7. Framing Around Duct Penetration Through Wall: Follow notes for vertical framing at openings and framing over openings noted above. Set stud framing to clear penetrations by approximately 1/4 inch.
- F. Furring:
1. Install intermediate bracing at spaces sufficient to provide substantial foundation for collateral materials or other supported items.
 2. Secure furring channels vertically at 16 inch on centers.
 3. Completely frame openings with channel.
- G. Suspended Ceiling and Soffit Framing:
1. Secure suspended ceiling to structural framing using hangers, 1-1/2 inch hot rolled carrying channels, and furring channels.
 2. Do not use Drop-In type expansion anchors for installing suspended ceiling.
 3. Hangers: Space hangers maximum four feet on center along carrying channels spaced maximum four feet on center.
 4. Cross Furring Channels: Attach furring channels to carrying channels at maximum 16 inches on center.
 5. Do not penetrate duct work with hangers.
 6. Properly support construction. Do not support ceiling hung gypsum board construction from MEPFP systems, or MEPFP systems support.
 7. Provide additional carrying channels, etc. to clear interfering construction elements in furred area. Do not use scrap material or ceiling tees.
 8. Where main runners are spliced, ends shall be overlapped minimum 12 inches with flanges of channels interlocked and securely tied near each end of splice with wire looped twice around channel.
 9. Space ceiling wires at least six inches from unbraced ducts, pipes and similar items.
 10. Provide hanger wires at intersections of grid members at corners of light fixtures.
 11. Completely frame openings with channels.
 12. Install compression and resistance struts as noted.
- H. Backing in Stud Partitions or Furring:
1. Typical: Securely weld or screw cut sections of unpunched stud, flat plates, or bent plates to at least three studs or furring supports, leaving flat surface of backing stud web to receive attachment of object to be secured.
 2. Verify that any pre-drilling of backing and attachment of spacers to prevent crushing of collateral material is done prior to application of collateral material. Use of toggle bolts without specified backing material is not an acceptable means of securing items.
 3. If it is determined by the Architect that backing was not provided for any items as required, the Contractor shall remove the finish material and install the backing. The contractor shall patch and refinish the surface to match adjacent areas and surfaces.
- I. Partitions Terminating at Structure: Attach top runner to structure, maintain clearance between top of studs and structure, and connect studs to track using specified mechanical devices in

accordance with manufacturer's instructions; verify free movement of top of stud connections; do not leave studs unattached to secondary track. (Do not make mechanical connection to deflection track.)

- J. Align and secure top and bottom runners at 24 inches (600 mm) on center.
- K. At partitions indicated with an acoustic rating:
 - 1. Provide components and install as required to produce minimum STC rating of 45 or as indicated on drawings, based on published tests by manufacturer conducted in accordance with ASTM E 90 with STC rating calculated in accordance with ASTM E 413.
 - 2. Place two beads of acoustic sealant between runners and substrate, studs and adjacent construction.
 - 3. Place two beads of acoustic sealant between studs and adjacent vertical surfaces.
 - 4. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.
- L. Fit runners under and above openings; secure intermediate studs to same spacing as wall studs.
- M. Align stud web openings horizontally.
- N. Stud splicing is not permissible.
- O. Fabricate corners using a minimum of three studs.
- P. Install double studs at wall openings, door and window jambs, not more than 2 inches (50 mm) from each side of openings.
- Q. Brace stud framing system rigid.
- R. Coordinate erection of studs with requirements of door frames and window frames; install supports and attachments.
- S. Coordinate installation of bucks, anchors, and blocking with electrical, mechanical, and other work to be placed within or behind stud framing.
- T. Blocking: Use fire treated wood blocking or steel channels secured to studs. Provide blocking for support of plumbing fixtures, toilet partitions, wall cabinets, toilet accessories, hardware, opening frames, and as required to properly support items indicated.

END OF SECTION 09 2216

SECTION 09 3000
TILING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Tile for wall applications.
- B. Adhesive Materials.
- C. Mortar.
- D. Grout.
- E. Non-Ceramic trim.
- F. Waterproofing / crack isolation membrane systems.

1.02 RELATED REQUIREMENTS

- A. Section 09 2116 - Gypsum Board Assemblies: Moisture resistant gypsum board and cementitious backer board substrates.

1.03 REFERENCE STANDARDS

- A. ANSI A108/A118/A136.1 - American National Standard Specifications for the Installation of Ceramic Tile (Compendium); 2013.1.
 - 1. ANSI A108.4 - American National Standard Specifications for Installation of Ceramic Tile with Organic Adhesives or Water Cleanable Tile-Setting Epoxy Adhesive; 2009 (Revised).
 - 2. ANSI A108.6 - American National Standard Specifications for Installation of Ceramic Tile with Chemical Resistant, Water Cleanable Tile-Setting and -Grouting Epoxy; 1999 (Reaffirmed 2010).
 - 3. ANSI A108.10 - American National Standard Specifications for Installation of Grout in Tilework; 1999 (Reaffirmed 2010).
 - 4. ANSI A118.3 - American National Standard Specifications for Chemical Resistant, Water Cleanable Tile-Setting and -Grouting Epoxy and Water Cleanable Tile-Setting Epoxy Adhesive; 2013 (Revised).
 - 5. ANSI A136.1 - American National Standard for Organic Adhesives for Installation of Ceramic Tile; 2012.1.
 - 6. ANSI A137.1 - American National Standard Specifications for Ceramic Tile; 2012.
- B. TCNA (HB) - Handbook for Ceramic, Glass, and Stone Tile Installation; 2016.

1.04 SUBMITTALS

- A. See Special Conditions, Submittals, for submittal procedures.
- B. Product Data: Provide manufacturers' data sheets on tile, mortar, grout, and accessories. Include instructions for using grouts and adhesives.
- C. Shop Drawings: Indicate tile layout, patterns, color arrangement, perimeter conditions, junctions with dissimilar materials, control and expansion joints, tile accessories, and setting details.
- D. Samples: Mount tile and apply grout on two plywood panels, minimum 18 by 18 inches (457 by 457 mm) in size illustrating pattern, color variations, and grout joint size variations.
- E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- F. Maintenance Data: Include recommended cleaning methods, cleaning materials, and stain removal methods.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing tile installation, with minimum five years documented experience and approved by manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect adhesives from freezing or overheating in accordance with manufacturer's instructions.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Do not install solvent-based products in an unventilated environment.
- B. Maintain ambient and substrate temperature at a minimum of 50 degrees F (10 degrees C) during installation of mortar materials.

1.08 EXTRA MATERIALS

- A. Provide 2 percent of each size, color, and surface finish of tile and trim units specified, but not less than one carton of each type. Provide in original unbroken containers plainly marked with type and quantity of contents.

PART 2 PRODUCTS

2.01 TILE

- A. Manufacturers: All products by the following manufacturers:
 - 1. Daltile: www.daltile.com.
 - 2. Fireclay Tile: www.fireclaytile.com.
 - 3. Substitutions: See Special Conditions - Substitutions.
- B. Wall Tile: (T-1) ANSI A 137.1 as follows:
 - 1. "Fabrique".
 - 2. Size: 12" x 24" x 3/8", installed vertically.
 - 3. Edge: Rectified.
 - 4. Color: Creme Linen, P686, Matte.
- C. Wall (Accent) Tile: (T-2) ANSI A137.1 as follows:
 - 1. "Original Ceramic Tile", by Fireclay Tile.
 - 2. Size: 1"x4" mosaic, high accent, straight sheeted, installed vertically.
 - 3. Edge: Hardmade tile.
 - 4. Color: Kelp.
 - 5. Trim Units: Non-metalic trim at top of accent band per detail.

2.02 TRIM AND ACCESSORIES

- A. Ceramic Trim: Matching bullnose ceramic shapes in sizes coordinated with field tile.
 - 1. Applications:
 - a. Open Edges: Bullnose.
 - b. Inside Corners: Jointed.
 - 2. Manufacturers: Same as for tile.
- B. Non-Ceramic Trim: Brushed stainless steel, style and dimensions as indicated on the drawings for setting using tile mortar or adhesive.
 - 1. Bottom of wall tile above integral cove sheet vinyl base.
 - 2. Top of wall to terminate accent tile to painted wall above.
 - 3. Schluter System "Jolly", coordinate unit with tile thickness.
 - 4. Manufacturers:
 - a. Schluter Systems: www.schluter.com.
 - b. Substitutions: See Special Conditions.

2.03 ADHESIVE MATERIALS

- A. Manufacturers:
 - 1. W.R. Bonsal Co: www.bonsal.com.
 - 2. Laticrete International, Inc.

3. Bostik, Inc: www.bostik-us.com.
 4. Substitutions: See Special Conditions - Substitutions.
- B. Epoxy Adhesive: ANSI A118.3, thinset bond type, use at porcelain tile flooring/base. Same as Laticrete's "Latapoxy 300 Epoxy Adhesive" or approved equal.

2.04 GROUTS

- A. Manufacturers:
1. Laticrete International, Inc.
 2. Substitutions: See Special Conditions - Substitutions.
- B. Epoxy Grout: ANSI A118.3, epoxy grout in horizontal and vertical grades; standard colors as-selected by Architect from manufacturers standard range; minimum four colors selected; use for all applications. Same as Laticrete's "Spectra Lock".
1. Color:
 - a. Restroom Wall Tile: Laticrete #90, Light Pewter.

2.05 ACCESSORY MATERIALS

- A. Gypsum Board Tile Backer Board: As specified in Section 09 2116.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive tile.
- B. Verify that wall surfaces are dust-free, and free of substances which would impair bonding of setting materials to wall surfaces.

3.02 PREPARATION

- A. Protect surrounding work from damage.
- B. Vacuum clean surfaces and damp clean.
- C. Seal substrate surface cracks with filler. Level existing substrate surfaces to acceptable flatness tolerances.
- D. Prepare substrate surfaces for adhesive installation in accordance with adhesive manufacturer's instructions.

3.03 INSTALLATION - GENERAL

- A. Install tile and grout in accordance with applicable requirements of ANSI A108.1 through A108.10, manufacturer's instructions, and TCA Handbook recommendations.
- B. Lay tile to pattern indicated. Do not interrupt tile pattern through openings.
- C. Cut and fit tile to penetrations through tile, leaving sealant joint space. Form corners and bases neatly. Align floor joints.
- D. Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make joints watertight, without voids, cracks, excess mortar, or excess grout. T-1 and T-2 joints \leq to 1/8".
- E. Form internal angles coved and external angles bullnosed.
- F. Sound tile after setting. Replace hollow sounding units.
- G. Keep control and expansion joints free of mortar, grout, and adhesive.
- H. Prior to grouting, allow installation to completely cure; minimum of 48 hours.
- I. Grout tile joints. Use epoxy grout at walls unless otherwise indicated.

- J. At changes in plane and tile-to-tile control joints, use tile sealant instead of grout, with either bond breaker tape or backer rod as appropriate to prevent three-sided bonding.

3.04 INSTALLATION - WALL TILE

- A. Over gypsum board tile backer units on metal studs install in accordance with TCA Handbook Method W244, thin-set epoxy adhesive over gypsum board tile backer unit walls.
- B. Grout with epoxy grout.
- C. Seal joints between tile work and other work with sealant Type 2 specified in Section 07900.

3.05 CLEANING

- A. Clean tile and grout surfaces.

3.06 PROTECTION

- A. Do not permit traffic over finished floor surface for 3 days after installation.

END OF SECTION 09 3000

SECTION 09 5100
ACOUSTICAL CEILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Suspended metal grid ceiling systems.
- B. Perimeter edge trims.
- C. Acoustical units.

1.02 RELATED SECTIONS

- A. Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 07 9200 - Joint Sealants: Acoustical sealant.
- C. Section 08 3100 - Access Doors and Panels: Access panels.
- D. Section 09 5300 - Acoustical Insulation: Acoustical insulation above ceiling system.
- E. Section 21 1313 - Wet Pipe Sprinkler Systems: Sprinkler heads in ceiling system.
- F. Section 23 3713 - Diffusers, Registers, and Grilles: Air diffusion devices in ceiling.
- G. Section 26 5000 - Interior Lighting: Light fixtures in ceiling system.
- H. Section 28 3111 - Digital, Addressable Fire Alarm System: Fire alarm components in ceiling system.

1.03 REFERENCE STANDARDS

- A. ASTM C635/C635M - Standard Specification for Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings; 2022.
- B. ASTM C636/C636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels; 2019.
- C. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2012.
- D. ASTM E580/E580M - Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions; 2022.
- E. ASTM E1264 - Standard Classification for Acoustical Ceiling Products; 2014.
- F. NFPA 286 - Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth; 2015.
- G. UL (FRD) - Fire Resistance Directory; Current Edition.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.
- B. Do not install acoustical units until after interior wet work is dry.

1.05 SUBMITTALS

- A. See Special Conditions - Submittals, for submittal procedures.
- B. Shop Drawings: Indicate grid layout and related dimensioning, junctions with other ceiling finishes, and mechanical and electrical items installed in the ceiling.
- C. Product Data: Provide data on suspension system components, acoustical units, and accessories.

- D. Samples: Submit two samples 6 by 6 inch (150 by 150 mm) in size illustrating material and finish of acoustical units.
- E. Samples: Submit two samples each, 6 inches (150 mm) long, of suspension system main runner, cross runner, and perimeter molding.
- F. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.
- G. LEED Submittal: Documentation of recycled content and location of manufacture.

1.06 QUALITY ASSURANCE

- A. Fire-Resistive Assemblies: Complete assembly listed and classified by UL (FRD) for the fire resistance indicated.
- B. Architectural reflective ceiling plan drawings shall govern over mechanical and electrical drawings.
- C. Should the Contractor at any time discover a discrepancy on the drawings with governing codes, he shall notify the Architect for clarification and shall not proceed with the Work affected until clarification has been made.
- D. All metallic components used for ceiling grid system and hangers in the MRI Exam Room shall be non-ferrous.

1.07 FIELD CONDITIONS

- A. Maintain uniform temperature of minimum 60 degrees F (16 degrees C), and maximum humidity of 40 percent prior to, during, and after acoustical unit installation.

1.08 PROJECT CONDITIONS

- A. Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.
- B. Install acoustical units after interior wet work is dry.
- C. Sequencing: Coordinate acoustical ceiling work with mechanical and electrical work.

1.09 EXTRA MATERIALS

- A. Extra Stock: Provide two full unbroken containers of each type of acoustical surface installed. Provide in original unbroken containers plainly marked with type and quantity of contents.

PART 2 PRODUCTS

2.01 ACOUSTICAL UNITS

- A. Manufacturers:
 - 1. Armstrong World Industries, Inc: www.armstrong.com.
 - 2. Acoustic Ceiling Products, Inc.: www.acpideas.com.
 - 3. CertainTeed Corporation: www.certainteed.com.
 - 4. USG: www.usg.com.
 - 5. Substitutions: See Section 01 2500 - Substitutions.
- B. Acoustical Units - General: ASTM E1264, Class A.
 - 1. VOC Content: As specified in Section 01 6116.
- C. Acoustical Panels Type 1: Painted mineral fiber, ASTM E 1264 Type III, with the following characteristics:
 - 1. Size: 24 x 24 inches (600 x 600 mm).
 - 2. Thickness: 3/4 inches (19 mm).
 - 3. Composition: Wet formed mineral fiber.

4. Light Reflectance: 82 percent, determined as specified in ASTM E 1264.
 5. NRC Range: 55.
 6. Ceiling Attenuation Class (CAC): 35, determined as specified in ASTM E 1264.
 7. Edge: Square Lay-In.
 8. Surface Color: White.
 9. Product: Ultima Lay-In #1910 by Armstrong World Industries, Inc.
 10. Suspension System: Exposed grid Type 1.
- D. Acoustical Tile Type 2: Painted mineral fiber, ASTM E 1264 Type IV with to the following characteristics:
1. Size: 24 x 24 inches (600 x 600 mm).
 2. Thickness: 3/4 inches (19 mm).
 3. Composition: Wet formed mineral fiber.
 4. Light Reflectance: 82 percent, determined as specified in ASTM E 1264.
 5. NRC: .60, determined as specified in ASTM E 1264.
 6. Ceiling Attenuation Class (CAC): 33, determined as specified in ASTM E 1264.
 7. Edge: Square Lay-In.
 8. Surface Color: White.
 9. Surface Pattern: Fine Textured.
 10. Product: Mesa Lay-In #680 by Armstrong World Industries.
 11. Suspension System: Grid Type 1.
- E. Acoustical Panels Type 3 (ACT-3): ASTM E1264 Type XII, Form III, Painted glass fiber, with the following characteristics:
1. Size: 24 x 24 inches (600 x 600 mm).
 2. Thickness: 3/4 inches (19 mm).
 3. Composition: High density glass wool fiber.
 4. Light Reflectance: 84 percent.
 5. NRC Range: .85.
 6. Edge: Square Lay-In.
 7. Surface Color: White.
 8. Product: Hygiene Protec A by Ecophon Acoustical Ceilings.
 9. Suspension System: Exposed grid Type 2 at MRI Exam Rooms only.

2.02 SUSPENSION SYSTEM(S)

- A. Manufacturers:
1. Armstrong World Industries, Inc: www.armstrong.com.
 2. Acoustic Ceiling Products, Inc.: www.acpideas.com.
 3. CertainTeed Corp. (formerly BPB): www.bpb-na.com.
 4. Chicago Metallic Corporation: www.chicagometallic.com.
 5. USG: www.usg.com.
 6. Substitutions: See Section 01 2500 - Substitutions.
- B. Metal Suspension Systems - General: Complying with ASTM C635/C635M; die cut and interlocking components, with stabilizer bars, clips, splices, perimeter moldings, and hold down clips as required.
- C. ExposedSteel Suspension System Type I: Formed steel, commercial quality cold rolled; heavy-duty.
1. Profile: Tee; Double flange for square and tegular edge panels; 15/16 inch (24 mm) wide face.
 2. Construction: Double web.
 3. Finish: White painted.
 4. Products:

- a. "Prelude XL 15/16 Inch Exposed Tee", by Armstrong World Industries, Inc..
 - b. Substitutions: See Section 01 2500 - Substitutions.
- D. Exposed Aluminum Suspension System (Type 2): Extruded aluminum; non-ferrous; intermediate-duty.
1. Profile: Double flange; 15/16 inch (24 mm) wide face.
 2. Finish: Painted white.
 3. Product: "AL Prelude Plus XL" by Armstrong World Industries, or approved equal.

2.03 ACCESSORIES

- A. Support Channels and Hangers: Galvanized steel; size and type to suit application, seismic requirements, and ceiling system flatness requirement specified.
- B. Hanger Wire: 12 gauge, 0.08 inch (2 mm) galvanized steel wire, aluminum wire at MRI Exam Room.
- C. Suspension System Accessories:
1. Power Driven Fasteners: Tempered steel pins, minimum 0.145 inch diameter, with corrosive-resistant plating or coating. Pins shall have guide washers to accurately control penetration, minimum 1-1/4 inches unless otherwise noted. Fastening shall be accomplished by low-velocity piston-driven powder-actuated tool. Pins and tool shall be same as manufactured by Hilti Fastening Systems; Impex Tool Corp.; or approved equal.
 2. Pin and Clip Anchors for Vertical Suspension Wires at Acoustical Board Ceiling Only: Same as Hilti Fastening Systems' "No. CC27DN27P8T Suspended Ceiling Clip"; or approved equal.
 3. Expansion Anchors: Fed. Spec. FF-S-325, Group II, Type 4, size as required. Same as Hilti Fastening Systems "Kwik-Bolt III Concrete Expansion Anchors and Hilti Drop-In Anchors"; Wej-It Expansion Products, Inc.'s "Wej-It Concrete Anchors and Wej-It Drop-In Anchors"; or approved equal.
 4. Hanger Wire: Fed. Spec. QQ-W-461H, Finish 5, Class 1, soft temper or ASTM A641, Class 1 Coating, soft temper; minimum 12 gauge for maximum four foot square module.
 5. Hanger wires at aluminum grid shall be aluminum or other non-ferrous metal.
- D. Perimeter Moldings: Same material and finish as grid.
1. Exposed Trim: 0.025 inch thick cold-rolled steel. Factory finished in baked-on white enamel with matte finish. Plastic joints or fasteners at wall angles will not be permitted. Provide standard angles and "W" mold profiles as shown on the drawings.
 2. Exposed trims at aluminum grid shall be aluminum, factory finished white.
- E. Seismic Restraint:
1. Reference Sheet A0.1 for typical design criteria for seismic restraint of acoustical ceiling systems.
 2. Manufacturer to provide seismic perimeter clips for standard 15/16" wall mold as tested and approved by ICC-ES and submit product with the manufacturer's approved testing number.
- F. Touch-up Paint: Type and color to match acoustical and grid units.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
1. Verify installation of building components located in ceiling plenum is complete.
 2. Verify spacing, direction, and details of grid members and supports to accommodate installation of light fixtures, diffusers, and other items as shown on Reflected Ceiling Plan are correct.

3. Verify areas are clean and free of materials or rubble that could damage acoustical surfaces.
- B. Verify that layout of hangers will not interfere with other work.

3.02 INSTALLATION - SUSPENSION SYSTEM

- A. Install suspension system in accordance with ASTM C 636, ASTM E 580, and manufacturer's instructions and as supplemented in this section.
- B. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.
- C. Unless otherwise noted, lay out system to a balanced grid design with edge units no less than 50 percent of acoustical unit size.
- D. Locate system on room axis according to reflected plan.
- E. Install after major above-ceiling work is complete. Coordinate the location of hangers with other work.
- F. Hanger Wires:
 1. Plumb hanger wires. Add counterbrace wires when hanger wires are more than one in six out of plumb.
 2. Hanger wires shall be fastened with not less than three tight turns within a distance of 1-1/2 inches for vertical wires and four tight turns within a distance of 1-1/2 inches for diagonal wires. Hanger or diagonal wire anchors to the structure should be installed in such a manner that the direction of the wire aligns as closely as possible with the direction of the forces acting on the wire.
 3. Provide additional 1-1/2 inch cold-rolled channel framing and hanger wires to clear furred-area interferences with suspension system. Do not penetrate ductwork with hanger wires and do not use scrap tee members.
 4. Separate all ceiling hanging and diagonal wires at least six inches from all unbraced ducts, pipes, conduit, etc. It is acceptable to attach lightweight items, such as single electrical conduit not exceeding 3/4 inch nominal diameter, to hanger wires using connectors acceptable to the Architect.
 5. Provide hanger wires at intersections of grid members at corners of light fixtures.
 6. Provide additional wire supports for all flush or recessed light fixtures, air terminals or services as follows:
 - a. Fixtures, Air Terminals or Services weighing less than 56 pounds: Provide minimum two 12 gauge hanger wires, as slack safety wires, attached at diagonal corners for fixtures. All 48 by 48 light fixtures shall have slack safety wires at each corner.
 - b. Fixtures, Air Terminals or Services weighing more than 56 pounds: Provide not less than four 12 gauge taut wires attached to the structure above regardless of the type of ceiling grid system used.
 - c. Provide four taut 12 gauge wires attached to the structure above, for all fixtures and air terminals or services supported on intermediate duty grid systems.
 - d. The four taut 12 gauge wires including their attachment to the structure above must be capable of supporting four times the weight of the unit.
 - e. Support surface mounted light fixtures by at least two positive devices which surround the ceiling runner and which are supported from the structure above by a 12 gauge wire. Spring clips or clamps that connect only to the runner are not acceptable.
 7. Splices will not be permitted in any hanger wires.
- G. Provide hanger clips during steel deck erection. Provide additional hangers and inserts as required.
- H. Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.

1. Use of scrap or short-cut members is not permitted.
 2. Span width of corridor using main runners equal to or greater than corridor width. Joining of two or more short ends to make additional runners will not be permitted.
 3. Connect exposed grid members with positive interlocking method as standard with approved manufacturer.
 4. Interconnect cross runners over 12 inches long and all main runners not interconnected to walls near free end with number 16 gauge tie wire or a metal strut securely attached to prevent lateral spreading. Where the perpendicular distance from the wall to the first parallel runner is 12 inches or less, this interlock is not required.
 5. Level grid assembly in each area after installation of mechanical and electrical equipment.
 6. Provide hold down clips at acoustical board where noted.
- I. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.
 - J. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.
 - K. Support fixture loads using supplementary hangers located within 6 inches (152 mm) of each corner, or support components independently.
 - L. Do not eccentrically load system or induce rotation of runners.
 - M. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
 1. Use longest practical lengths.
 2. Miter corners.
 3. Install profiled perimeter moldings where noted on the drawings.

3.03 INSTALLATION - ACOUSTICAL UNITS

- A. Install acoustical units in accordance with manufacturer's instructions.
- B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.
- C. Lay directional patterned units with pattern parallel to longest room axis.
- D. Fit border trim neatly against abutting surfaces.
- E. Install units after above-ceiling work is complete.
- F. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.
- G. Cutting Acoustical Units:
 1. Cut to fit irregular grid and perimeter edge trim.
 2. Make field cut edges of same profile as factory edges.
 3. Double cut and field paint exposed reveal edges.
- H. Where round obstructions and bullnose concrete block corners occur, provide preformed closures to match perimeter molding.

3.04 TOLERANCES

- A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet (3 mm in 3 m).
- B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.
- C. Reference Finish Schedule for location of materials.

3.05 SCHEDULE

END OF SECTION 09 5100

SECTION 09 5300
ACOUSTICAL INSULATION

PART 1 GENERAL

1.01 DESCRIPTION

- A. Work Included in this Section: Acoustical insulation and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 01 6000 - Product Requirements.
- B. Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.

1.03 INCORPORATED DOCUMENTS

- A. Published specifications, standards, tests, or recommended methods of trade, industry, or governmental organizations apply to work of this Section where cited by abbreviations noted below.
 - 1. Federal Specifications (Fed. Spec.).

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical products only after glazing has been completed, exterior opening closed in, and wet work completed and dried out.
- B. Deliver and store packaged products in original containers with seals unbroken and labels intact until time and use.

1.05 JOB CONDITIONS

- A. Sequencing: Coordinate acoustical insulation with mechanical and electrical work.

1.06 SUBMITTALS

- A. See Special Conditions - Submittals, for submittal procedures.
- B. Product Data.

PART 2 PRODUCTS

2.01 ACOUSTICAL INSULATION

- A. Nonfaced, friction fit, mineral fiber blanket, 1 1/2 and 2-1/2 inches thick, unless otherwise noted, and meeting requirements of Fed. Spec. HH-I-521F, Type I. Same as USG Interiors, Inc.'s "Thermafiber SAFB"; or approved equal.
- B. Substitutions: See Section 01 2500 - Substitutions.

2.02 ACCESSORIES

- A. Insulation Support: String wire, staples, and nails as required.

PART 3 EXECUTION

3.01 PREPARATION

- A. Examine areas to receive insulation for conditions that will adversely affect installation and performance.
- B. Do not start work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install insulation in accordance with manufacturer's recommendations.
- B. Install insulation to fit snugly between framing members and around pipes, conduits, and outlet boxes as necessary to maintain integrity of insulation.
- C. Provide means to prevent displacement where required.

- D. Butt ends of insulation closely together and fill all voids. Allow air space between insulation and back of opposite gypsum wallboard face layer.

3.03 DEFECTIVE WORK

- A. Remove insulation in areas deemed defective and replace with new material conforming to requirements.
- B. Restore to original condition work of other sections damaged in repair or replacement of defective work.
- C. Remove or replace work damaged by weather.

END OF SECTION 09 5300

**SECTION 09 6500
RESILIENT FLOORING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Resilient sheet flooring.
- B. Integral cove base.
- C. Resilient base.
- D. Installation accessories.
- E. Preparation of existing substrate to receive new flooring.

1.02 RELATED REQUIREMENTS

- A. Section 03 5400 - Cast Underlayment.

1.03 REFERENCE STANDARDS

- A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials ; 2016.
- B. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source; 2019a, with Editorial Revision (2020).
- C. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring; 2011.
- D. ASTM E 662 - Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials ; 2015..
- E. ASTM F1303 - Standard Specification for Sheet Vinyl Floor Covering with Backing; 2004 (Reapproved 2021).
- F. ASTM F1861 - Standard Specification for Resilient Wall Base; 2021.
- G. ASTM F1913 - Standard Specification for Vinyl Sheet Floor Covering Without Backing; 2019.
- H. ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes; 2019a.
- I. NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source; 2023.
- J. RFCI (RWP) - Recommended Work Practices for Removal of Resilient Floor Coverings; Resilient Floor Covering Institute; October 2011.

1.04 PERFORMANCE REQUIREMENTS

- A. Conform to applicable code for fire performance ratings as follows:
 - 1. Critical radiant flux (CRF): Minimum 0.45 watt per square centimeter, per ASTM E 648.
 - 2. Flame spread: Maximum 75, per ASTM E 84.
 - 3. Smoke developed: Maximum 450, per ASTM E 84.
 - 4. Smoke density: Maximum 450, per ASTM E 662.

1.05 SUBMITTALS

- A. See Special Conditions - Submittal Procedures.
- B. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.
- C. Shop Drawings: Indicate seaming plan and patterns for floors and walls.

- D. Verification Samples: Submit two samples, 6 by 6 inch (150 by 150 mm) in size illustrating color and pattern for each resilient flooring product specified.
- E. Concrete Testing: Submit a copy of test reports required within this section.
- F. Certification: Prior to installation of flooring, submit written certification by flooring manufacturer and adhesive manufacturer that condition of subfloor is acceptable.
- G. Maintenance Manuals: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, stripping, and re-waxing.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time for use.
- B. Protect roll materials from damage by storing on end.
- C. Store floor tile material on flat surfaces.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Maintain temperature in storage area between 55 degrees F (13 degrees C) and 90 degrees F (72 degrees C).
- B. Store materials for not less than 48 hours prior to installation in area of installation at a temperature of 70 degrees F (21 degrees C) to achieve temperature stability. Thereafter, maintain conditions above 55 degrees F (13 degrees C).

1.08 MOISTURE BLOCKING SEALER

- A. Included in this section is a moisture blocking sealer to be applied to all concrete substrates.
- B. Contractor to include furnishing and installing the specified product in their base bid to the Contractor, however the cost for this system application shall be identified as a separate line item in their bid, which will be removed if the application is not required.
- C. Application of this product shall in no way limit or alter the flooring products manufacturer's warranty.

1.09 EXTRA MATERIALS

- A. Provide ten (10) percent of each pattern and color of resilient flooring material and 40 lineal feet of each type of base installed. Provide in original unbroken containers plainly marked with type and quantity of contents.
 - 1. Sheet Flooring: Extra material shall be in full width rolls.
 - 2. Floor Tile: Provide quantities as listed above and not less than one (1) box for each type, color, and pattern.

PART 2 PRODUCTS

2.01 MATERIALS - SHEET FLOORING

- A. Heterogeneous Vinyl Sheet (SV-1): Meet performance requirements of ASTM F 1303, ISO 10581, Type I, Grade 1, Class B sheet vinyl floor covering with backing, color and pattern through total thickness:
 - 1. Total Thickness: 0.080 inch (2.0 mm) nominal.
 - 2. Wear Layer Thickness: 0.800 in. (0.80 mm).
 - 3. Sheet Width: 78 inch (2.0 m) minimum.
 - 4. Static Load Limit: 175 psi minimum.
 - 5. Heat welded seams.
 - 6. Pattern: Tone on tone, non-directional design.
 - 7. Manufacturers:
 - a. Tarkett, Acczent Prosper.

- b. Substitutions: Not permitted.
- 8. Color: Reference Color and Material Legend; minimum of two (2) colors.
- 9. Pattern: Reference Architectural drawings for flooring pattern / layout.
- B. Homogeneous Vinyl Sheet (SV-2): Meet performance requirements of ASTM F 1913, Type II, color and pattern throughout total thickness:
 - 1. Total Thickness/Wear Layer Thickness: 0.080 inch (2.0 mm) nominal.
 - 2. Sheet Width: 78 inches (2.0 m) nominal.
 - 3. Static Load Limit: 250 psi minimum.
 - 4. Heat Weld Seams.
 - 5. Pattern: Random repeat, reverse sheet for seaming.
 - 6. Manufacturers:
 - a. Mannington Commercial, "Assurance III".
 - b. Substitutions: Not permitted.
 - 7. Color: Khaki #16344.
 - 8. Pattern: None.
- C. Vinyl Welding Rod (Flooring type SV-1/SV-2): Solid vinyl bead produced by manufacturer of vinyl flooring for heat welding seams, in colors as selected by Architect; minimum of two (2) colors.
- D. Integral Cove Base:
 - 1. Cove base up wall six (6) inches; four (4) inches at restroom.
 - 2. Provide cove filler and metal cap strip.
 - 3. Provide pre-molded outside and inside corners.

2.02 MATERIALS - RESILIENT BASE

- A. Resilient Base - Type 1: ASTM F1861, Type TS rubber, vulcanized thermoset Style B, Cove; style as scheduled.
 - 1. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E 648.
 - 2. Height: 4 inch (100 mm).
 - 3. Thickness: 0.125 inch thick.
 - 4. Finish: Matte.
 - 5. Length: Roll stock. Note 4 foot piece stock not acceptable.
 - 6. Color: Color as selected from manufacturer's standard line, minimum of two (2) colors selected.
 - 7. Accessories: Premolded external corners and internal corners.
 - 8. Manufacturers:
 - a. Johnsonite, a Tarkett Company: www.johnsonite.com.
 - b. Substitutions: Not permitted.

2.03 ACCESSORIES

- A. Underlayment / Floor Levelor: Reference Section 03 5400 - Cast Underlayment.
- B. Primers and Adhesives: Waterproof; types recommended by flooring manufacturer.
- C. Performed Resilient Flooring Clean Corners: Same as Gerflor's "Radius System" (in Operating Rooms) and "Thermoform System" in Corridors.
- D. Moldings and Transition Strips: Vinyl, color as selected from manufacturer's standard range. Same as the following Johnsonite Rubber Company's products.
 - 1. Colors: Colors as selected by Architect for each area supplied.
- E. Metal Cap Strip: Aluminum cap strip in J-mold design to be installed at top of sheet vinyl integral cove bases maximum lengths possible. Same as "Futura's 1/8" Square Metal Cove Cap" or approved equal.

- F. Filler for Coved Base: Plastic, as recommended by flooring manufacturer.
- G. Heat Welding Rods: As per manufacturer's standard.
- H. Sealer for Concrete Slab Surfaces: Apply one (1) coat of sealer to existing floor slab surfaces.
 - 1. Prepare surface of existing concrete as required by manufacturer and apply primer. Same as Vexcon Chemical, Inc.'s "Moisture Bloc MX Primer," or approved equal.
 - 2. Apply sealer one (1) coat per manufacturer's written instructions. Same as Vexcon Chemical Inc.'s "Moisture Bloc MX" or approved equal (as acceptable to flooring manufacturer to maintain warranty).

PART 3 EXECUTION

3.01 EXAMINATION

- A. Remove existing flooring and existing adhesive to substrate. Properly prep substrate to receive new flooring.
- B. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring and integral base to substrate.
- C. Verify that wall surfaces are smooth, flat and are dust-free, ready to receive base and wall protection materials.
- D. Cementitious Subfloor Surfaces: Verify that substrates are ready for resilient flooring installation by testing for moisture and alkalinity (pH).
 - 1. Test in accordance with 1.
 - 2. Obtain instructions if test results are not within limits recommended by resilient flooring manufacturer and adhesive materials manufacturer.
- E. Verify that sub-floor surfaces are dust-free and free of substances which would impair bonding of adhesive materials to sub-floor surfaces.
- F. Flooring vendor shall verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels according to manufacturer's written instructions. Perform moisture tests in accordance with ASTM requirements and so that each test area does not exceed 200 sq. ft. (18.6 sq. m.) and perform no fewer than two tests in each installation. For some projects, Owner may engage a qualified testing company in addition to flooring vendor's testing. Contractor always has the option of independently testing and trending slabs for moisture. All test results shall be delivered to design team and Owner.
 - 1. Perform anhydrous calcium chloride test, ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours or limit as acceptable in writing by flooring manufacturers.
 - 2. Perform relative humidity test using in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75% relative humidity level measurement or limit as acceptable in writing by flooring manufacturers.
 - 3. Perform alkalinity tests and additional tests as recommended by flooring manufacturer. Proceed with installation only after substrates meet the requirements.
- G. Contractor is responsible to deliver an acceptable substrate to the flooring installer and in accordance with the construction schedule. Contractor may be required to provide temporary heat and/or dehumidification to adequately dry new concrete slabs to receive floor finishes. Contractor is required to provide moisture control system on all concrete substrate regardless of existing moisture conditions.
- H. Contractor shall remove coatings, including curing compounds, and other substances on substrates that are incompatible with installation adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.

Broom or vacuum clean substrates to be covered immediately before product installation. After cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust. Proceed with installation only after unsatisfactory conditions have been corrected.

- I. Verify that required floor-mounted utilities are in correct location.
- J. Contractor to verify existing gypsum board substrate where existing integral base has been removed is properly prepared to receive new integral base prior to the start of the work.
- K. Flooring Patterns: Contractor to assume three (3) sheet vinyl colors with a field and pattern. Assume pattern cut(s) will be radius cuts in lieu of straight line. Reference Architectural drawings for layout and pattern.

3.02 PREPARATION

- A. Remove existing resilient flooring and flooring adhesives; follow the recommendations of 1.
- B. Remove sub-floor ridges and bumps. Fill minor low spots, cracks, joints, holes, and other defects with sub-floor filler to achieve smooth, flat, hard surface. Follow the recommendations of RFCI Recommended Work Practices for removal of resilient floor coverings.
- C. Prepare floor substrates as recommended by flooring and adhesive manufacturers.
- D. Prohibit traffic until filler is fully cured.
- E. Clean substrate.
- F. Apply primer as required to prevent "bleed-through" or interference with adhesion by substances that cannot be removed.

3.03 INSTALLATION - GENERAL

- A. Starting installation constitutes acceptance of subfloor conditions.
- B. Install in accordance with manufacturer's written instructions.
- C. Spread only enough adhesive to permit installation of materials before initial set.
- D. Fit joints and butt seams tightly.
- E. Set flooring in place, press with heavy roller to attain full adhesion.
- F. Where type of floor finish, pattern, or color are different on opposite sides of door, terminate flooring under centerline of door.
- G. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated.
- H. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.

3.04 INSTALLATION - SHEET FLOORING

- A. Install in accordance with manufacturer's instructions.
- B. Spread only enough adhesive to permit installation of materials before initial set.
- C. Set flooring in place, press with heavy roller to attain full adhesion.
- D. Lay flooring with joints and seams parallel to longer room dimensions, to produce minimum number of seams. Lay out seams to avoid widths less than 1/3 of roll width; match patterns at seams.
- E. Lay flooring with tightly bolted seams, without any seam sealer unless otherwise indicated.
- F. Double cut sheet at seams.
- G. Lay flooring with tightly butted seams, without any seam sealer unless otherwise indicated.
- H. Finish seams in sheet vinyl by heat welding.

- I. Double cut sheet; provide heat welded seams.
- J. Where floor finishes are different on opposite sides of door, terminate flooring under centerline of door.
- K. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated. Secure resilient strips by adhesive.
- L. Integral Coved Base: Install where indicated on drawings, using coved base filler as backing at floor to wall junction. Extend sheet vinyl flooring vertically 6 inches (100 mm), and cover top edge with metal cap strip with exception of where PVC wall panels are used (Operating Rooms). Weld seams as recommended by manufacturer.
- M. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.
- N. At movable partitions, install flooring under partitions without interrupting floor pattern.
- O. Coordinate preparation of steel plate for installation of finish flooring.

3.05 INSTALLATION - BASE

- A. Fit joints tightly and make vertical. Maintain minimum dimension of 72 inches (1828 mm) between joints.
- B. Miter internal corners. At external corners, job form. At exposed ends, use premolded units.
- C. Install base on solid backing. Bond tightly to wall and floor surfaces.
- D. Scribe and fit to door frames and other interruptions.

3.06 CLEANING

- A. Remove excess adhesive from floor, base, and wall surfaces without damage.
- B. Clean in accordance with manufacturer's written instructions.
- C. Clean and seal resilient flooring products in accordance with manufacturer's instructions.

3.07 PROTECTION

- A. Prohibit traffic on resilient flooring for 48 hours after installation.

3.08 SCHEDULE

- A. Reference Color and Material Legend on drawings.

END OF SECTION 09 6500

SECTION 09 6813
TILE CARPETING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Moisture barrier.
- B. Concrete substrate testing.
- C. Carpet tile, fully adhered.

1.02 RELATED REQUIREMENTS

- A. Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 03 5400 - Cast Underlayment.
- C. Section 09 6500 - Resilient Flooring: Termination edging of adjacent floor finish and resilient base.

1.03 REFERENCE STANDARDS

- A. ASTM D2859 - Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials; 2016 (Reapproved 2021).
- B. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source; 2019a, with Editorial Revision (2020).
- C. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring; 2011.
- D. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride; 2016a.
- E. ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes; 2019a.
- F. CRI 104 - Standard for Installation of Commercial Carpet; 2015.
- G. CRI (GLP) - Green Label Plus Testing Program - Certified Products; Current Edition.
- H. NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source; 2023.

1.04 SUBMITTALS

- A. See Special Conditions for submittal procedures.
- B. Shop Drawings: Indicate layout of joints, direction of carpet pile, and location of edge moldings.
- C. Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.
- D. Shop Drawings: Indicate layout of joints, direction of carpet pile, and location of edge moldings.
- E. Samples: Submit two carpet tiles illustrating color and pattern design for each carpet color selected.
- F. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.
- G. Concrete Subfloor Test Report: Submit a copy of the moisture and alkalinity (pH) test reports.
- H. Operation and Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning.
- I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
- J. LEED Report: Report VOC emission of flooring; VOC content of adhesives.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing specified carpet tile with minimum three years documented experience.
- B. Installer Qualifications: Company specializing in installing carpet tile with minimum three years documented experience and approved by carpet tile manufacturer.

1.06 FIELD CONDITIONS

- A. Store materials in area of installation for minimum period of 24 hours prior to installation.

1.07 MOISTURE BLOCKING SEALER

- A. Included in this section is a moisture blocking sealer and associated mechanical floor slab preparation to be applied at all locations to receive carpet tile flooring products specified herein.
- B. Contractor to include furnishing and installing the specified product in their base bid to the Contractor, however the cost for this system application shall be identified as a separate line item in their bid, which will be removed if the application is not required.
- C. Application of this product shall in no way limit or alter the flooring products manufacturer's warranty.

1.08 EXTRA MATERIALS

- A. Not less than two percent of each pattern and color of carpet tile flooring material. Provide in original unbroken containers plainly marked with type and quantity of contents.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Carpet Tile (CPT-1): Commercial quality, textured pattern loop, modular carpet tile, manufactured in one color dye lot.
 - 1. Product: "Entwined-Moso", manufactured by Mannington.
 - 2. Tile Size: 24 x 24 inches (60.96 cm x 60.96 cm).
 - 3. Yarn System: 100% Recycled Content Type 6, 6 Nylon.
 - 4. Color: #84334, Acorn.
 - 5. Pattern: Textured pattern loop, brick ashlar install.
 - 6. Smoke Density: NBS Smoke Chamber NFPA-258-less than 450 Flaming Mode.
 - 7. Radiant Panel Test: NFPA Class I when tested under ASTM E-648 glue down.
 - 8. Flammability: Passes DOC-FF-1-70 Pill Test.
 - 9. Static: <3 Kv. at 20 percent relative humidity.
 - 10. Dye System: 100% solution dyed.
 - 11. Gauge: 5/64 inch (50.39 ends/10 cm).
 - 12. Stitches: 10 per inch (39.37/10 cm).
 - 13. Yard Weight: 22 oz/sq. yd. (746 gm/m).
 - 14. Pile Thickness: .14 inches (3.56 mm).
 - 15. Primary Backing: Infinity 2 Modular.
 - 16. VOC Content: Provide CRI (GLP) certified product; in lieu of labeling, independent test report showing compliance is acceptable.

2.02 ACCESSORIES

- A. Sub-Floor Filler: Reference Section 03 5400.
- B. Adhesives:
 - 1. Compatible with materials being adhered; maximum VOC content of 50 g/L; CRI (GLP) certified; in lieu of labeled product, independent test report showing compliance is acceptable.

- C. Carpet Tile Adhesive: Recommended by carpet tile manufacturer; releasable type.
- D. Sealer for Concrete Slab Surfaces: Apply one (1) coat of sealer to existing floor slab surfaces if required due to moisture content.
 - 1. Prepare surface of existing concrete as required by manufacturer and apply primer. Same as Vexcon Chemical, Inc.'s "Moisture Bloc MX Primer", or approved equal.
 - 2. Apply sealer one (1) coat per manufacturer's written instructions. Same as Vexcon Chemical, Inc.'s "Moisture Blox MX".

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that subfloor surfaces are smooth and flat within tolerances specified for that type of work and are ready to receive carpet tile.
- B. Verify that subfloor surfaces are dust-free and free of substances that could impair bonding of adhesive materials to subfloor surfaces.
- C. Verify that concrete sub-floor and self leveling underlayment surfaces are dry enough and ready for flooring installation by testing for moisture emission rate and alkalinity in accordance with ASTM F710; obtain instructions if test results are not within limits recommended by carpet tile manufacturer and adhesive materials manufacturer.
- D. Verify that concrete sub-floor surfaces are ready for carpet tile installation by testing for moisture emission rate and alkalinity; obtain instructions if test results are not within limits recommended by carpet tile manufacturer and adhesive materials manufacturer.
- E. Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION

- A. Remove subfloor ridges and bumps. Fill minor or local low spots, cracks, joints, holes, and other defects with subfloor filler.
- B. Apply, trowel, and float filler to achieve smooth, flat, hard surface. Prohibit traffic until filler is cured.
- C. Vacuum clean substrate.

3.03 INSTALLATION

- A. Starting installation constitutes acceptance of subfloor conditions.
- B. Install carpet tile in accordance with manufacturer's instructions.
- C. Blend carpet from different cartons to ensure minimal variation in color match.
- D. Cut carpet tile clean. Fit carpet tight to intersection with vertical surfaces without gaps.
- E. Lay carpet tile in brick ashlar pattern, with pile direction parallel to next unit, set parallel to building lines.
- F. Locate change of color or pattern between rooms under door centerline.
- G. Fully adhere carpet tile to substrate.
- H. Trim carpet tile neatly at walls and around interruptions.
- I. Complete installation of edge strips, concealing exposed edges.

3.04 CLEANING

- A. Remove excess adhesive without damage, from floor, base, and wall surfaces.
- B. Clean and vacuum carpet surfaces.

END OF SECTION 09 6813

SECTION 09 9123
INTERIOR PAINTING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Surface preparation.
- B. Field application of paints, stains, and varnishes.
- C. Materials for backpriming woodwork.
- D. Scope: Finish interior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated, including the following:
 - 1. Both sides and edges of plywood backboards for electrical and telecom equipment before installing equipment.
 - 2. Mechanical and Electrical:
 - a. In finished areas, paint conduit, boxes, hangers, brackets, collars and supports, unless otherwise indicated.
 - b. In all areas, paint shop-primed items.
 - c. Paint interior surfaces of air ducts that are visible through grilles and louvers with one coat of flat black paint to visible surfaces.
 - d. Paint dampers exposed behind louvers, grilles, to match face panels.
- E. Do Not Paint or Finish the Following Items:
 - 1. Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.
 - 2. Items indicated to receive other finishes.
 - 3. Items indicated to remain unfinished.
 - 4. Fire rating labels, equipment serial number and capacity labels, bar code labels, and operating parts of equipment.
 - 5. Stainless steel, anodized aluminum, bronze, terne-coated stainless steel, and lead items.
 - 6. Marble, granite, slate, and other natural stones.
 - 7. Floors, unless specifically indicated.
 - 8. Ceramic and other tiles.
 - 9. Brick, architectural concrete, cast stone, integrally colored plaster, and stucco.
 - 10. Glass.
 - 11. Concrete masonry units in utility, mechanical, and electrical spaces.
 - 12. Acoustical materials, unless specifically indicated.
 - 13. Concealed pipes, ducts, and conduits.

1.02 RELATED REQUIREMENTS

- A. Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 05 5000 - Metal Fabrications: Shop-primed items.
- C. Section 21 0553 - Identification for Fire Suppression Piping and Equipment: Painted identification.
- D. Section 22 0553 - Identification for Plumbing Piping and Equipment: Painted identification.
- E. Section 23 0553 - Identification for HVAC Piping and Equipment: Color coding scheme for items to be painted under this section.
- F. Section 26 0553 - Identification for Electrical Systems: Color coding scheme for items to be painted under this section.

1.03 DEFINITIONS

- A. Comply with 1 for interpretation of terms used in this section.

1.04 REFERENCE STANDARDS

- A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; current edition.
- B. ASTM D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications; 2014.
- C. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials; 2020.
- D. MPI (APL) - Master Painters Institute Approved Products List; Master Painters and Decorators Association; Current Edition.
- E. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual; Current Edition.
- F. SSPC V1 (PM1) - Good Painting Practice: Painting Manual Volume 1; 2016.
- G. SSPC-SP 1 - Solvent Cleaning; 2015, with Editorial Revision (2016).
- H. SSPC-SP 2 - Hand Tool Cleaning; 2018.
- I. SSPC-SP 3 - Power Tool Cleaning; 2018.

1.05 SUBMITTALS

- A. See Special Conditions - Submittals, for submittal procedures.
- B. Product Data: Provide complete list of products to be used, with the following information for each:
 - 1. Manufacturer's name, product name and/or catalog number, and general product category (e.g., "alkyd enamel").
 - 2. MPI product number (e.g., MPI #47).
 - 3.
 - 4. Manufacturer's installation instructions.
 - 5. If proposal of substitutions is allowed under submittal procedures, explanation of substitutions proposed.
- C. Samples: Submit three paper "draw down" samples, 8-1/2 by 11 inches (216 by 279 mm) in size, illustrating range of colors available for each finishing product specified.
 - 1. Where sheen is specified, submit samples in only that sheen.
 - 2. Where sheen is not specified, discuss sheen options with Architect before preparing samples, to eliminate sheens not required.
 - 3. Allow 15 days for approval process, after receipt of complete samples by Architect.
- D. Certification: By manufacturer that paints and finishes comply with VOC limits specified.
- E. Manufacturer's Instructions: Indicate special surface preparation procedures and substrate conditions requiring special attention.
- F. Maintenance Data: Submit coating maintenance manual including product technical data sheets, material safety data sheets (MSDS), care and cleaning instructions, touch-up procedures, and repair of painted and finished surfaces.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified, with minimum ten years documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified with minimum five years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.

- B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- C. Paint Materials: Store at minimum ambient temperature of 45 degrees F (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in ventilated area, and as required by manufacturer's instructions.

1.08 FIELD CONDITIONS

- A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.
- B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
- C. Do not apply materials when relative humidity exceeds 85 percent, at temperatures less than 5 degrees F (3 degrees C) above the dew point, or to damp or wet surfaces.
- D. Minimum Application Temperatures for Paints: 50 degrees F (10 degrees C) for interiors unless required otherwise by manufacturer's instructions.
- E. Minimum Application Temperature for Varnish Finishes: 65 degrees F (18 degrees C) for interior, unless required otherwise by manufacturer's instructions.
- F.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Provide paints and finishes from the same manufacturer to the greatest extent possible.
 - 1. If a single manufacturer cannot provide specified products; minor exceptions will be permitted provided approval by Architect is obtained using the specified procedures for substitutions.
 - 2. Substitution of MPI-approved products by a different manufacturer is preferred over substitution of unapproved products by the same manufacturer.
- B. Paints:
 - 1. Sherwin-Williams Company: www.sherwin-williams.com/#sle.
- C. Transparent Finishes:
 - 1. Sherwin-Williams Company: www.sherwin-williams.com/#sle.
 - 2. Pratt and Lambert.
- D. Stains:
 - 1. Sherwin-Williams Company: www.sherwin-williams.com/#sle.
 - 2. Pratt and Lambert.
 - 3. Olympic Stains.
- E. Primer Sealers: Same manufacturer as top coats.
- F. Substitutions: Not permitted.

2.02 PAINTS AND FINISHES - GENERAL

- A. Paints and Finishes: Ready mixed, unless intended to be a field-catalyzed paint.
 - 1. Where MPI paint numbers are specified, provide products listed in Master Painters Institute Approved Product List, current edition available at www.paintinfo.com, for specified MPI categories, except as otherwise indicated.
 - 2. Provide paints and finishes of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.

3. Provide materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
 4. For opaque finishes, tint each coat including primer coat and intermediate coats, one-half shade lighter than succeeding coat, with final finish coat as base color.
 5. Supply each paint material in quantity required to complete entire project's work from a single production run.
 6. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is specifically described in manufacturer's product instructions.
- B. Volatile Organic Compound (VOC) Content: Comply with Section 01 6116.
- C. Flammability: Comply with applicable code for surface burning characteristics.
- D. Sheens: Provide the sheens specified; where sheen is not specified, sheen will be selected later by Architect from the manufacturer's full line.
- E. Colors: As indicated in Color Schedule.
1. Allow for minimum of three colors for each system, unless otherwise indicated, without additional cost to Owner.
 2. Extend colors to surface edges; colors may change at any edge as directed by Architect.
 3. In finished areas, finish pipes, ducts, conduit, and equipment the same color as the wall/ceiling under which they are mounted.

2.03 PAINT SYSTEMS - INTERIOR

- A. Paint WI-TR-VS - Wood, Transparent, Varnish, Stain:
1. Filler coat (for open grained wood only).
 2. One coat of stain.
 3. One coat sealer.
 4. Satin: Two coats of varnish.
- B. Paint MI-OP-2A - Ferrous Metals, Primed, PreCatalyzed Water Based Epoxy, 2 Coat:
1. Touch-up with acrylic primer: B66W310 Pro Industrial Pro-Cryl Universal Prime.
 2. Semi-gloss: Two coats of PreCatalyzed Water Based Epoxy: K46W151 Pro Industrial Pre-Catalyzed Water Based Semi Gloss Epoxy.
- C. Paint CI-OP-3E - Gypsum Board, Waterbased Two Component Polyamine Epoxy, 3 Coat:
1. One coat of acrylic latex primer sealer: B28W2600 ProMar 200 Zero VOC Interior Latex Primer.
 2. Eggshell: Two coats of two component water-based polyamine epoxy: B73W361 Pro Industrial Waterbased Catalyzed Epoxy - Eg-Shel.
- D. Paint GI-OP-3L - Gypsum Board/Plaster, Latex, 3 Coat, Odor Reducing, VOC Reducing, Anti-Microbial, Zero VOC Product:
1. One coat of acrylic latex primer sealer: B28E2600 ProMar 200 Zero VOC Interior Latex Primer.
 2. Eggshell: Two coats of acrylic latex enamel: B9W1051 Harmony Interior Acrylic Eg-Shel.
- E. Paint GI-OP-3LA - Gypsum Board/Plaster, Latex-Acrylic, 3 Coat, Odor Reducing, VOC Reducing, Anti-Microbial, Zero VOC Product:
1. One coat of acrylic primer sealer: B28W2600 ProMar 200 Zero VOC Interior Latex Primer.
 2. Eggshell: Two coats of acrylic latex enamel: B5W1051 Harmony Interior Acrylic Flat.

2.04 PRIMERS

- A. Primers: Provide the following unless other primer is required or recommended by manufacturer of top coats.

2.05 ACCESSORY MATERIALS

- A. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of painted surfaces.
- B. Patching Material: Latex filler.
- C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin application of paints and finishes until substrates have been adequately prepared.
- B. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- C. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially effect proper application.
- D. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- E. Test shop-applied primer for compatibility with subsequent cover materials.
- F. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:
 - 1. Gypsum Wallboard: 12 percent.
 - 2. Interior Wood: 15 percent, measured in accordance with ASTM D4442.

3.02 PREPARATION

- A. Clean surfaces thoroughly and correct defects prior to application.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Remove or repair existing paints or finishes that exhibit surface defects.
- D. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.
- E. Seal surfaces that might cause bleed through or staining of topcoat.
- F. Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate; tri-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.
- G. Gypsum Board: Fill minor defects with filler compound. Spot prime defects after repair.
- H. Plaster: Fill hairline cracks, small holes, and imperfections with latex patching plaster. Make smooth and flush with adjacent surfaces. Wash and neutralize high alkali surfaces.
- I. Insulated Coverings: Remove dirt, grease, and oil from canvas and cotton.
- J. Ferrous Metal:
 - 1. Solvent clean according to SSPC-SP 1.
 - 2. Shop-Primed Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Re-prime entire shop-primed item.
- K. Wood Surfaces to Receive Opaque Finish: Wipe off dust and grit prior to priming. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats. Back prime concealed surfaces before installation.
- L. Wood Surfaces to Receive Transparent Finish: Wipe off dust and grit prior to sealing, seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after sealer has dried; sand lightly between coats. Prime concealed surfaces with gloss varnish reduced 25 percent with thinner.

- M. Wood Doors to be Field-Finished: Seal wood door top and bottom edge surfaces with clear sealer.

3.03 APPLICATION

- A. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
- B. Apply products in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual".
- C. Where adjacent sealant is to be painted, do not apply finish coats until sealant is applied.
- D. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
- E. Apply each coat to uniform appearance in thicknesses specified by manufacturer.
- F. Dark Colors and Deep Clear Colors: Regardless of number of coats specified, apply as many coats as necessary for complete hide.
- G. Sand wood and metal surfaces lightly between coats to achieve required finish.
- H. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
- I. Wood to Receive Transparent Finishes: Tint fillers to match wood. Work fillers into the grain before set. Wipe excess from surface.
- J. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.04 CLEANING

- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.05 PROTECTION

- A. Protect finishes until completion of project.
- B. Touch-up damaged finishes after Substantial Completion.

3.06 FINISHING MECHANICAL AND ELECTRICAL EQUIPMENT

- A. Refer to Divisions 22, 23, and 26 for labeling requirements and refer to BJC Color Coding of new piping and conduit schedule painting requirements.
- B. Paint shop-primed equipment, where indicated.
- C. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
- D. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.
- E. Unless otherwise noted in Divisions 22, 23, and 26, paint only those mechanical, equipment, ductwork, piping, conduit items that are exposed to view.

3.07 LABELING BARRIERS

- A. All smoke, fire, corridor and other rated walls and floors shall be marked to clearly identify the rating of the barrier, in uppercase block letters at least 3" in height, and in a color and shade that sharply contrasts against the background surface. Rating shall read:

LABEL	TEXT COLOR
SMOKE BARRIER	YELLOW

SMOKE WALL	YELLOW
CORRIDOR WALL	YELLOW
1 HR FIRE BARRIER	RED
2 HR FIRE BARRIER	RED
3 HR FIRE BARRIER	RED
4 HR FIRE BARRIER	RED

- B. Markings shall be permanent, and may be left by stamps or stencil using roller ink, or paint only 3" lettering. Additionally, inks and paints must not pose an indoor air quality issue in occupied space.
- C. The barrier labeling process shall be supervised and final work accepted either by:
 - 1. Degreed professional; such as an architect, engineer, or project manager.
 - 2. Or by a competent individual, skilled in the trade of reading and understanding drawings of record/construction blueprints.
- D. Walls:
 - 1. Walls in finished spaces shall be labeled on both sides above the ceiling grid.
 - 2. Walls in unfinished spaces shall be labeled on both sides ten feet off the floor, or 18 inches below the deck above 12".
 - 3. Markings shall repeat every 15 feet along the entire length of the wall.
 - 4. In areas where mechanical, electrical, structural or other obstruction make it difficult or impossible to see the markings, the repeat shall increase such that a worker can immediately locate the mark upon lifting a ceiling tile or being within 4 feet off the floor above.

3.08 SCHEDULE - PAINT SYSTEMS

- A. Gypsum Board: Finish surfaces exposed to view.
 - 1. Interior Ceilings and Bulkheads: GI-OP-3LA, flat.
 - 2. Interior Walls: GI-OP-3L, Eggshell (typical unless otherwise noted).
 - 3. Interior Walls: CI-OP-3E, Eggshell (Lab Room).
- B. Wood: Finish surfaces exposed to view.
- C. Wood Doors/Trim: WI-TR-VS.
- D. Steel Door Frames: Finish surfaces exposed to view; MI-OP-2A, semi-gloss.
- E. Shop-Primed Metal Items: Finish surfaces exposed to view.
 - 1. Interior: MI-OP-2A.

END OF SECTION 09 9123

SECTION 10 2123
CUBICLE CURTAIN, TRACK, AND HARDWARE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Surface mounted overhead metal curtain track, hardware, and guides from salvage.
- B. Cubicle curtains from salvage.

1.02 RELATED REQUIREMENTS

- A. Section 09 5100 - Suspended Acoustical Ceilings: Suspended ceiling system to support track.

1.03 REFERENCE STANDARDS

- A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2016.

1.04 SUBMITTALS

- A. See Special Conditions - Submittals, for submittal procedures.
- B. Product Data: Provide data for curtain and track and guides.
- C. Shop Drawings: Indicate a reflected ceiling plan view of curtain track, hangers and suspension points, attachment details.
- D. Samples
 - 1. Submit 12 inch (300 mm) sample length of curtain track including typical splice and wall and ceiling hanger and escutcheon.
 - 2. Curtain Fabric: Verification samples in 18 inch swatch or larger to show complete pattern repeat, dye lot, and with fire retardant treatment, including top mesh material.
- E. Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention .

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Tracks:
 - 1. Cubicle curtain: From salvage.
- B. Curtains
 - 1. From salvage.

2.02 TRACKS AND TRACK COMPONENTS

- A. Track: Extruded aluminum sections.
 - 1. Structural Performance: Capable of supporting vertical test load of 50 lbs (23 kg) without visible deflection of track or damage to supports, safely supporting moving loads, and sufficiently rigid to resist visible deflection and without permanent set.
 - 2. Track End Stop, Tees, Y's, and Switches: To fit track section.
 - 3. Track Bends: Minimum 12 inch (300 mm) radius; fabricated without deformation of track section or impeding movement of carriers.
 - 4. Suspension Rods: Tubular Aluminum sections, sized to support design loads and designed to receive attachment from track and ceiling support.
 - 5. Escutcheons to Suspension Rods: Aluminum.
 - 6. Finish on Exposed Surfaces: Powder coated white finish.

2.03 CUBICLE CURTAINS

- A. Performance Requirements: Provide curtain fabrics with the following characteristics:
 - 1. Fabrics are launderable to a temperature of not less than 160 deg F.

2. Fabrics are flame resistant and are identical to those that have passed NFPA 701 when tested by a testing and inspecting agency acceptable to authorities having jurisdiction.
 3. Identify fabrics with appropriate markings of applicable testing and inspecting agency.
- B. Cubicle Curtain Fabric: Curtain manufacturer's standard, 100 percent polyester, in herently and permanently flame resistant, stain resistant, and antimicrobial.
1. Basis of Design: arcCom AC 33090 Sensu / Palm #1 with antimicrobial treatment - designed for attachment to track without seperate hooks.

2.04 CURTAIN FABRICATION

- A. Fabricate curtains to comply with the following requirements:
1. Width: Equal to track length from which curtain is hung plus 10 percent added fullness, but not less than 12 inches added fullness.
 2. Length: Equal to floor-to-ceiling height, with 20-inch mesh top, and minus distance above the finished floor at bottom as follows:
 3. Length: Equal to floor-to-ceiling height minus 18 inches from finished ceiling at top, and minus 12 inches distance above the finished floor at bottom as follows:
 4. Top Hem: Not less than 1 inch and not more than 1-1/2 inches wide, triple thickness, reinforced with integral web, and double lock stitched.
 5. Mesh Top: Top hem not less than 1 inch and not more than 1-1/2 inches wide, triple thickness, reinforced with integral web, and double lock stitched. Double lock stitch bottom of mesh directly to 1/2 inch triple thickness, top hem of curtain fabric.
 6. Bottom Hem: Not less than 1 inch and not more than 1-1/2 inches wide, triple thickness, reinforced, and double lock stitched.
 7. Side Hems: Not less than 1/2 inch and not more than 1-1/4 inches wide, with triple turned edges, and single lock stitched.
- B. Vertical Seams: Not less than 1/2 inch wide, double turned and double stitched.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces and supports above ceiling are ready to receive work of this Section.
- B. Verify that field measurements are as indicated on shop drawings.

3.02 INSTALLATION

- A. Install curtain track to be secure, rigid, and true to ceiling line.
- B. Install end cap and stop device.
- C. Secure track to ceiling system.
- D. Hang curtains on each curtain track. Secure with curtain tieback.

END OF SECTION 10 2123

SECTION 10 2601
WALL AND CORNER GUARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Corner guards/Edge guards.
- B. Crashrails.
- C. Protective wallcovering.
- D. Coordination with existing salvaged wall and corner guard protection.

1.02 RELATED REQUIREMENTS

- A. Section 06 1000 - Rough Carpentry: Support blocking for wall and corner guard anchors.
- B. Section 06 2000 - Finish Carpentry: Installation of products specified in this section.
- C. Section 09 2116 - Gypsum Board Assemblies.
- D. Section 09 2216 - Non-Structural Metal Framing: Wall construction.

1.03 REFERENCE STANDARDS

- A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- B. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2015.
- C. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.

1.04 PERFORMANCE REQUIREMENTS

- A. Installed Wall Rail Component Assembly: Support vertical live load of 100 lb/lineal ft (1,400 N/m) with deflection not to exceed 1/50 of span between supports.
- B. Installed Component Assembly: Resist lateral force of 75 lbs (333 N) at any point without damage or permanent set.
- C. Corner Guards: Resist lateral impact force of 100 lbs (445 N) at any point without damage or permanent set.

1.05 SUBMITTALS

- A. See Special Conditions - Submittals, for submittal procedures.
- B. Product Data: Indicate physical dimensions, features, wall mounting brackets with mounted measurements, anchorage details, rough-in measurements, and coordination with existing components.
- C. Samples: Submit two sets of color samples illustrating color and finish.
- D. Shop Drawings: Indicate location, dimensions, mounting details.
- E. Manufacturer's Instructions: Indicate special procedures, perimeter conditions requiring special attention.

1.06 QUALITY ASSURANCE

- A. Perform Work in accordance with ANSI/CABO A117.1 requirements for the physically handicapped.
- B. Fire Resistance: Where fire ratings are specified for components, provide assemblies that have been tested and rated in accordance with ASTM E 119.

1.07 PROJECT CONDITIONS

- A. Coordinate the work with wall or partition sections for installation of concealed blocking or anchor devices.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Wall and Cornerguards designed and specified are based on Inpro Corporation, Inc.
- B. Edge and Corner Guards:
 - 1. Inpro Corporation
 - a. Corner Guard: 150 SM-20 (Surface Mounted).
 - b. Edge Guard: 150 SSM-25N (Surface Mounted).
 - c. Corner Guard 150: SM-20M-135 degree corner (Surface Mounted).
- C. Crashrail:
 - 1. Inpro Corporation:
 - a. 140, 4" height, surface mounted.
 - b. 170, 7-3/4" height, surface mounted.
- D. Protective Wall Covering
 - 1. Construction Specialties, Acrovyn wallcovering.

2.02 COMPONENTS

- A. Corner Guard (CG-1): Flush Mounted: High impact vinyl with extruded aluminum full height retainer and integral impact absorbing device.
 - 1. Size: 3 inches (76 mm).
 - 2. Corner: Radiused.
 - 3. Color: As selected from manufacturer's standard colors, to match existing.
 - 4. Length: One piece; top of resilient base to ceiling.
 - 5. Preformed end caps.
- B. Edge Guard (CG-2) - Surface Mounted: Dual high impact vinyl with extruded aluminum full height retainer, internal impact absorbing device and wall protection sheet between units.
 - 1. Size: 2 inches (51 mm).
 - 2. Corner: Radiused.
 - 3. Color: As selected from manufacturer's standard range, to match existing.
 - 4. Length: One piece; top of resilient base to ceiling.
 - 5. Performed end caps.
- C. Crashrail:
 - 1. Material: High impact vinyl, with aluminum retainer and clips, color to match existing.
 - 2. Mounting: Surface.
 - 3. Size: 4 inch (102 mm) / 7-3/4" (197 mm).
 - 4. Projection From Wall to Outside of Rail: 1-1/4 inch (32 mm).
 - 5. Length: Minimum one piece length not less than 36 inches (914 mm); flush splicing.
- D. Protective Wall Covering: (Sheet Protection)
 - 1. Textured vinyl acrylic sheet material.
 - 2. Thickness: .060 inch thick.
 - 3. Include all inside, outside, and edge moldings.
 - 4. Adhesives: Type as recommended by manufacture. Same as used in test to determine flame spread ratings.
 - 5. Color: To match existing.
- E. Mounting Brackets and Attachment Hardware: Appropriate to component and substrate.

2.03 FABRICATION

- A. Fabricate components with tight joints, corners and seams.
- B. Pre-drill holes for attachment.
- C. Form end trim closure by capping and finishing smooth.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that rough-in for components are correctly sized and located.
- B. Verify that field measurements are as indicated on drawings.

3.02 INSTALLATION

- A. Install components in accordance with manufacturer's instructions, level and plumb, secured rigidly in position to wall framing members only.
- B. Position top of crashrail 36 inches (914 mm) from finished floor.
- C. Position corner guard 4 inches (101 mm) above finished floor to ceiling.
- D. Position edge guards 4 inches (101 mm) above finished floor to ceiling.
- E. Terminate rails 1-1/2 inches (38 mm) short of door opening.
- F. Return rails to wall.
- G. Protective Wall Covering:
 - 1. Install protective wall covering up to height as indicated on drawings.
 - 2. Install moldings at all corners, edges, terminations, and butt joints.
 - 3. Achieve invisible butt seams.
 - 4. Assure vertical alignment. Horizontal seams will not be allowed.
 - 5. No exposed fasteners will be permitted.
 - 6. Stagger joint alignment of handrail, crashrail, and wall protection.

3.03 ERECTION TOLERANCES

- A. Maximum Variation From Required Height: 1/4 inch (6 mm).
- B. Maximum Variation From Level or Plane For Visible Length: 1/4 inch (6 mm).

END OF SECTION 10 2601

SECTION 10 2800
TOILET ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Accessories for toilets, housekeeping closets, handwashing sinks, and miscellaneous areas.

1.02 RELATED REQUIREMENTS

- A. Section 09 2216 - Non-Structural Metal Framing: Placement of reinforcement for backing plate reinforcement.

1.03 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.
- C. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2015.
- D. ASTM B456 - Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium; 2011e1.

1.04 SUBMITTALS

- A. See Special Conditions - Submittals, for submittal procedures.
- B. Product Data: Submit data on accessories describing size, finish, details of function, and attachment methods.
- C. Manufacturer's Installation Instructions: Indicate special procedures and conditions requiring special attention.

1.05 COORDINATION

- A. Coordinate the work with the placement of internal wall reinforcement, concealed ceiling supports, and reinforcement of toilet partitions to receive anchor attachments.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturer's catalog numbers cited on drawings in Toilet Accessory Schedule indicate design, quality, capacity, function, and finish desired. All locks shall be keyed alike.
- B. Unless otherwise noted on the Toilet Accessory Schedule, model numbers indicate Bobrick Washroom Equipment, Inc. Substitutions are not permitted.

2.02 MATERIALS

- A. Accessories - General: Shop assembled, free of dents and scratches and packaged complete with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.
 - 1. Grind welded joints smooth.
 - 2. Fabricate units made of metal sheet of seamless sheets with flat surfaces.
- B. Keys: Provide 2 keys for each accessory to Owner; master key all lockable accessories.
- C. Stainless Steel Sheet: 1, Type 304.
- D. Stainless Steel Tubing: ASTM A269.
- E. Galvanized Sheet Steel: Hot-dipped galvanized steel sheet, 1, with G90/Z275 coating.
- F. Fasteners, Screws, and Bolts: Hot dip galvanized; tamper-proof; security type.

- G. Expansion Shields: Fiber, lead, or rubber as recommended by accessory manufacturer for component and substrate.

2.03 FINISHES

- A. Stainless Steel: Satin finish, unless otherwise noted.
- B. Chrome/Nickel Plating: 1, SC 2, polished finish, unless otherwise noted.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify exact location of accessories for installation.
- C. Verify that field measurements are as indicated on drawings.
- D. See Section 06 1000 - Rough Carpentry for installation of blocking, reinforcing plates, and concealed anchors in walls and ceilings.

3.02 PREPARATION

- A. Deliver inserts and rough-in frames to site for timely installation.
- B. Provide templates and rough-in measurements as required.

3.03 INSTALLATION

- A. Install accessories in accordance with manufacturers' instructions in locations indicated on drawings.
- B. Install plumb and level, securely and rigidly anchored to substrate.
- C. Mounting Heights: As required by accessibility regulations, unless otherwise indicated.
- D. Mounting Heights and Locations: As required by accessibility regulations or as indicated on drawings.
- E. Mounting Heights and Locations: As required by accessibility regulations and as indicated on drawings
- F. Installed grab bars shall withstand a minimum load or stress of 250 pounds point load applied at any point.

3.04 SCHEDULE

- A. Schedule: Reference Toilet Accessory Schedule as noted on the documents.

END OF SECTION 10 2800

SECTION 10 4400
FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fire extinguishers (MRI-compliant).
- B. Fire extinguisher cabinets.
- C. Relocation of existing fire extinguisher cabinet/fire extinguisher from salvage.

1.02 RELATED REQUIREMENTS

- A. Section 06 1000 - Rough Carpentry: Wood blocking product and execution requirements.
- B. Section 09 2216 - Non-Structural Metal Framing: Roughed-in wall openings.

1.03 REFERENCE STANDARDS

- A. 11
- B. NFPA 10 - Standard for Portable Fire Extinguishers; 2022.
- C. UL (DIR) - Online Certifications Directory; Current Edition.

1.04 SUBMITTALS

- A. See Special Conditions - Submittals, for submittal procedures.
- B. Product Data: Provide extinguisher operational features.
- C. Shop Drawings: Indicate locations of cabinets, cabinet physical dimensions, rough-in measurements for recessed cabinets, installation procedures, and accessories required for complete installation.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- E. Maintenance Data: Include test, refill or recharge schedules and re-certification requirements.

1.05 FIELD CONDITIONS

- A. Do not install extinguishers when ambient temperature may cause freezing of extinguisher ingredients.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Fire Extinguisher Cabinets and Accessories:
 - 1. JL Industries, Inc: www.jlindustries.com.
 - 2. Larsen's Manufacturing Co: www.larsensmfg.com.
 - 3. Potter-Roemer: www.potterroemer.com.
 - 4. Substitutions: See Section 01 2500 - Substitutions.

2.02 FIRE EXTINGUISHERS

- A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
 - 1. Provide extinguishers labeled by UL (DIR) or 1 for purpose specified and as indicated.
- B. Dry Chemical Type Fire Extinguishers: Non-ferrous metal tank, with pressure gage, suitable to be taken into the MRI Exam Room.
 - 1. Class: A:B:C type.
 - 2. Size: 5 pound (2.27 kg).
 - 3. Finish: Baked polyester powder coat, red color or non-ferrous stainless steel or aluminum as standard with manufacturer.

4. Same as Kidde's "Non-Magnetic MRI Fire Extinguisher," Newmatic Medical's "MRI Tested Fire Extinguisher - Rechargeable," or approved equal.

2.03 FIRE EXTINGUISHER CABINETS

- A. Cabinet Configuration: Recessed type (Type 1).
 1. Exterior nominal dimensions of 11-3/4 inch (298 mm) wide by 26-3/4 inch (680 mm) high by 6 inch (152 mm) deep.
 2. Projected Trim: Returned to wall surface, with 3/8 inch (9 mm) projection, and 1.5 inch (38 mm) wide face.
 3. Location: Reference plans for units installed in thickened partitions/funnel partitions
- B. Door: 0.036 inch (0.9 mm) metal thickness, reinforced for flatness and rigidity with nylon catch. Hinge doors for 180 degree opening with two butt hinge.
 1. Door Glazing: Float glass, clear, 1/8 inch (3 mm) thick, and set in resilient channel glazing gasket.
- C. Cabinet Mounting Hardware: Appropriate to cabinet, with pre-drilled holes for placement of anchors.
- D. Fabrication: Weld, fill, and grind components smooth.
 1. Finish of Cabinet Exterior Trim and Door: Thermally-fused polyester coating; White.
- E. Finish of Cabinet Interior: White enamel typical.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify rough openings for cabinet are correctly sized and located.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install MRI type extinguishers in Cyclotron vault and Cyclotron Equipment Room.
- C. Install cabinets plumb and level in wall openings, 36 inches (900 mm) from finished floor to inside bottom of cabinet.
- D. Secure rigidly in place.
- E. Place extinguishers in cabinets.

END OF SECTION 10 4400

SECTION 10 9990
MISCELLANEOUS SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Provision of miscellaneous specialty items including backing, attachment, or other work required for installation unless specifically noted otherwise. Items include, but are not necessarily limited to following:
 - 1. Coat hooks not associated with toilet rooms.

1.02 RELATED SECTIONS

- A. Section 06 1000 - Rough Carpentry: Placement of backing plate reinforcement concealed in walls for the secure attachment of work in this section.

1.03 SUBMITTALS

- A. See Special Conditions - Submittals, for submittal procedures.
- B. Product Data.
- C. Shop Drawings: Show layouts and methods of attachment.
- D. Samples: Only as requested.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged products in original containers with seals unbroken and labels intact until time of use.
- B. Store delivered products in clean, safe, dry area.

1.05 JOB CONDITIONS

- A. Scheduling, Sequencing: Schedule installation of items to occur after application of exposed finishes wherever installation will not damage exposed finish surfaces and completion of finishes will not impede installation.

PART 2 PRODUCTS

2.01 COAT HOOKS

- A. Same as Peter Pepper Products, Single Hook, Model "2081-AL".

PART 3 EXECUTION

3.01 PREPARATION

- A. Coordinate details with other work supporting, adjoining, or otherwise contacting items as required to insure proper installation.
- B. Insure adequate support will be available at time of installation.

3.02 INSPECTION

- A. Examine construction to support, adjoin, or otherwise contact and verify that:
 - 1. Dimensions are correct.
 - 2. Load-bearing studs are available where required by weight of items.
 - 3. Setting conditions are dry, clean, and otherwise proper for installation.
- B. Do not install items until unsatisfactory conditions have been corrected.

3.03 INSTALLATION

- A. General Requirements:
 - 1. Install items in accordance with approved manufacturer's recommendations and reviewed Shop Drawings.

2. Employ mechanics skilled in installation required.
 3. Typical Fastenings: Use expansion bolts in concrete and machine screws or bolts to metal backing. Toggle bolts will not be permitted.
 4. Drill and tap mounting surfaces for mounting hardware as required.
- B. Coat Hooks: Secure coat hooks to walls where noted on the drawings, in accordance with manufacturer's instructions. Contractor to coordinate/install wood or metal backing at all locations.
1. For coat hooks associated with toilet rooms, reference toilet accessory schedule

END OF SECTION 10 9990

SECTION 11 5000
EQUIPMENT RESPONSIBILITY

PART 1 GENERAL

1.01 DESCRIPTION

- A. This section defines abbreviations which have been assigned to equipment items specified in other sections of these specifications and Contract Documents in order to designate contract responsibility for such equipment items.
- B. Coordination of equipment responsibility.
- C. Contract Documents for Equipment Documentation including:
 - 1. Architectural documents for Plans and General Locations.
 - 2. Mechanical, Electrical, Plumbing and Fire Protection Documents.
 - 3. Equipment Vendor rough-in and site planning documents.
- D. Related Work Not Included in this Section:
 - 1. Unless otherwise noted, equipment items in accordance with equipment responsibility abbreviations.
 - 2. Rough-in of mechanical or electrical services.
 - 3. Backing.

1.02 DEFINITIONS

- A. Following equipment responsibility abbreviations where specified with equipment items shall establish corresponding contract responsibilities.
- B. General: Assignment of any equipment responsibility symbol to equipment item shall entail the Contractor's responsibility for following under work of the Contract.
 - 1. Verification of utility requirements for approved equipment items. Upon request, the Owner will make available dimensions and utility characteristics of Owner-furnished items.
 - 2. Provisions of utility rough-ins for equipment items where required irrespective of equipment responsibility designation unless specifically noted otherwise.
 - a. Rough-in locations, sizes, capacities, etc. shall be as noted.
 - b. If the Owner substitutes an item similar to that specified, there shall be no change in rough-in cost unless substitution occurs after rough-in is completed or rough-in involves other utilities or utilities of capacity different from that required by item originally specified.
- C. Abbreviation List:
 - 1. CFCI: Furnished by the Contractor: installed by the Contractor.
 - 2. OFCI: Furnished by the Owner; installed by the Contractor. The Owner and the Contractor will coordinate deliveries of equipment to coincide with construction schedule, thereby minimizing storage of equipment before installation.
 - a. The Owner will:
 - 1) Furnish all standard integral parts of equipment.
 - 2) Unless noted otherwise, tailgate-deliver items to site.
 - b. The Contractor shall:
 - 1) Receive item at site and give written receipt for item at time of delivery, noting visible defects or omissions; if such declaration is not given, the Contractor shall assume responsibility for such defects and omissions.
 - 2) Store item until ready for installation.
 - 3) Uncrate, assemble, and set item in place.
 - 4) Install items in accordance with manufacturer's recommendations, instructions, and Shop Drawings under supervision of manufacturer's representative,

supplying labor and material required and making mechanical, plumbing, and electrical connections necessary to operate equipment.

3. OFOI: Furnished by the Owner; installed by the Owner.
4. E-CI: Existing equipment to be relocated and installed by the Contactor.
 - a. The Contractor shall:
 - 1) Remove item from present location when directed by the Owner.
 - 2) Recap any existing utilities at present location.
 - 3) Relocate item to new location.
 - 4) Install item, provide fittings, fastenings, etc. required to place equipment in operating condition same as immediately prior to removal, unless additional work is noted in respective equipment list such as reconditioning or modifications other than those stated above.
5. E-OI: Existing equipment to be relocated and installed by the Owner.
6. F: Future item furnished by the Owner and installed by the Owner. The Contractor shall be responsible for satisfying space requirements and rough-ins.

1.03 SUBMITTALS

- A. See Special Conditions - Submittals, for submittal procedures.
- B. Only as required for equipment as provided under other sections of this Specifications or Contract Documents.

1.04 PRE-INSTALLATION MEETING

- A. Contractor to schedule meeting to convene one week minimum before starting any work associated with this section of work.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Assist the Owner in coordinating the scheduling of delivery of all items of equipment during the Construction of the facility.
- B. Make provisions for handling, storing, and temporary protection of all equipment during the construction period.

1.06 ENVIRONMENTAL REQUIREMENTS

- A. Do not store, and/or install, erect or otherwise place any equipment prior to Equipment Vendor recommended environmental conditions are met and maintained

PART 2 PRODUCTS

NO WORK

PART 3 EXECUTION

3.01 JOB CONDITIONS

- A. Do not install or place equipment until all requirements of Part One of this specifications are met.

3.02 EXAMINATION

- A. Verify that field conditions are acceptable including all space requirements, utility rough-ins and blocking.
- B. Where required contact responsible Equipment Vendor to examine jobsite conditions prior to installation of equipment

3.03 INSTALLATION

- A. Where required coordinate installation with Owner Equipment Vendor.
- B. Protect equipment from damage during installation and after placement.

- C. Coordinate the work of other contractors as required to provide for a complete and satisfactory installation.

3.04 EQUIPMENT VENDOR COORDINATION

- A. Where required and as designated assist the Owner with the coordination of Equipment Vendor installations including but not limited to:
 - 1. Schedule of Equipment Installation.
 - 2. Coordination with placement of rough-in for utilities and backing.
 - 3. Coordination of all interconnecting hose, wire and cable requirements between vendor equipment items and the connection types at each equipment item.
- B. Coordination of Equipment Vendor Clean Up.
- C. Coordination of Equipment Vendor Temporary Protection.

3.05 PROTECTION OF FINISHED WORK

- A. Provide temporary protection of equipment items as required to protect finishes, exposed corners and edges, and working parts.
- B. Protection to be comprised of appropriate and durable means.

END OF SECTION 11 5000

SECTION 13 4906
MRI - MAGNETIC SHIELDING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Work Included in this Section: Furnish all labor, materials, equipment, tools and related items to provide, fabricate, transport, install and test a magnetic shield system for MRI Exam Room 1238, as detailed on the design drawings and specified herein including but necessarily limited to:
 - 1. All floor and wall shielding panels and plates, including all necessary supports and fasteners for mounting steel sheets shielding to substrate.
 - 2. System testing.
- B. Related Activities: Work required by other trades is not included in this section. The following items shall be provided by other contractors and be coordinated with the Magnetic Shielding manufacturer.
 - 1. Any general construction work in connection with conventional construction enveloping the shielded enclosure and/or preparing surfaces to receive magnetic shielded enclosure.
 - 2. Any imaging equipment installation.

1.02 RELATED SECTIONS

- A. Section 01 5000 - Temporary Facilities and Controls: Site access and material/equipment staging areas.
- B. Section 03 0100 - Concrete Repair: Coordination with modified cementitious repair mortar over the top of the floor shielding to prepare flat surface for high density insulation installation.
- C. Section 05 4000 - Cold Formed Metal Framing: Support framing for wall shielding.
- D. Section 05 5000 - Metal Fabrications: Unistrut support members for RF ceiling support.
- E. Section 09 2216 - Non-Structural Metal Framing: Interior framing.
- F. Section 09 5300 - Acoustical Insulation.
- G. Section 13 4942 - Radio Frequency Shielded Enclosures: Related construction/coordination.
- H. Section 21 0000 - Supplementary Fire Suppression General Conditions.
- I. Section 22 0000 - Supplementary Plumbing General Conditions.
- J. Section 23 0000 - Supplementary Mechanical General Conditions.
- K. Section 26 0000 - Supplementary Electrical General Conditions.

1.03 REFERENCES

- A. MIL-STD-285-Methods of Attenuation Measurement for Electromagnetic Shielding Enclosures for Electronic Test Purposes.
- B. AISC-American Institute of Steel Construction.

1.04 QUALITY ASSURANCE

- A. The function of the magnetic shield assembly is to provide a free environment with a single point ground and defined magnetic fringe field containment. For this purpose, the interference free environment must meet the minimum functional requirements listed below.
 - 1. Magnetic field attenuation: 90 dB between 10 KHz and 100 MHz.
- B. Pre-construction Conference: The Contractor shall arrange a conference to be attended by the Owner, the Architect, the Contractor, the manufacturer's representative and approved installer, and all subcontractors having work associated with the construction of magnetic shielding. All participants shall have a minimum of 1 week's advance notice of conference and all listed

above shall be in attendance. Requirements of work, preparation, storage, delivery, handling, protective measures, coordination and interface with related work shall be discussed.

1.05 SUBMITTALS

- A. See Special Conditions - Submittals, for submittal procedures.
- B. Shop drawings shall be submitted for approval prior to fabrication. Shop drawings shall reflect the typical enclosure floor plan, ceiling plan, elevation, typical construction, sections, locations of miscellaneous penetrations, support components, and any other conditions which will affect the shielded enclosure.
- C. Structural calculations for intermediary support of shielding panels.

1.06 WARRANTY

- A. Enclosure shall be warranted against defective materials and workmanship for a period of five years from date of acceptance test.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. The manufacturer shall have a minimum of ten (10) years experience in the manufacture and installation of magnetic shielded enclosures with references and imaging system vendors, architectural / engineering firms and general contractors. Same as Braden Shielding Systems, 9260 Broken Arrow Expressway, Tulsa, Oklahoma 74145, (918) 624-2888; IMEDCO America Ltd, 1730 E. Pleasant Street, Noblesville, IN 46060 (317) 219-3562; ETS/Lindgren, Inc., 400 High Grove Blvd., Glendale Heights, IL 60139, (630) 307-7200.

2.02 WORK INCLUDED

- A. Provide complete magnetic shield envelope / plates as indicated on the documents to meet the performance requirements specified, including the following:
 - 1. Manufactured floor, wall and ceiling shield plates, including all necessary supports to 'parent structure' including secondary structural members, fasteners, etc.
 - 2. Cavity wall type construction shall be provided for concealed electrical conduit and related equipment as required in other specified sections.

2.03 MATERIALS

- A. Magnetic Plates: The basic plate enclosure shall consist of a structural support system with steel sheet shielding.
 - 1. Magnetic shield wall, floor, and ceiling panel: High silicon magnetic steel sheets (M36) layered to provide required thickness. Thickness as indicated on the design documents.
 - 2. Laminated magnetic shielding plates: Floor panels shall be factory laminated to thickness indicated for anchorage to concrete structure below.
- B. Magnetic Closure Pieces: High silicon magnetic steel sheet (M36) trims/closures as required by shielding vendor.
- C. Substrate: 3/4 inch (18 mm) thick fire treated plywood substrate for panelization of ceiling/wall shielding.

PART 3 EXECUTION

3.01 INSPECTION

- A. Before system fabrication/installation, verify the on-site conditions affecting work of this section. Report any discrepancies between building drawings, shop drawings and field conditions to the Architect and General Contractor prior to commencing installation.

3.02 FABRICATION

- A. Magnetic shielding to be fabricated and prepared for anchorage systems as specified or required by magnetic shielding.
- B. Laminated ceiling panels to be fabricated per manufacturer's recommendations, in thickness as noted on the drawings and in largest sizes as allowable for fabrication and installation due to weight.

3.03 INSTALLATION

- A. Installation shall be performed by or under the supervision of the shield vendor.
- B. Erection:
 - 1. Erect steel in accordance with AISC1 and AISC2.
 - 2. Insure steel is plumb, level and in accurate alignment before making final connections.
 - 3. Install magnetic shielding closure pieces at intersection of all shielding plates at intersecting planes.

3.04 TESTS

- A. Provide testing of magnetic shield in conjunction with Imaging Vendor.

END OF SECTION 13 4906

SECTION 13 4942
RADIO FREQUENCY SHIELDED ENCLOSURES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Furnish all labor, materials, and equipment tools, and related items to provide, fabricate, install and test a radio frequency shield system for MRI Exam Room 1238, as detailed on the design drawings and specified, including but necessarily limited to:
 - 1. Design of structure for self-supporting shielding enclosure including all hangers for suspension of R.F. shield enclosure ceiling from overhead structure.
 - 2. All floor, wall, and ceiling shielding panels and plates, including all necessary supports and fasteners.
 - 3. R.F. floor shield with monolithic floor system.
 - 4. System acoustically rated door units with metal frame, threshold, and hardware.
 - a. Pneumatic controlled RF shield door assemblies.
 - 5. System acoustically rated window units and frame including tempered glass.
 - 6. Waveguide air vents for HVAC.
 - 7. R.F. filters for all electrical, signal, and communication wires.
 - 8. All necessary waveguide penetrations for water, medical gases, O2 Monitors, etc.
 - 9. DC power filters for resistive MR systems (where specified by MR manufacturer).
 - 10. Specialty systems R.F. Filters.
 - 11. All di-electric connections, including anchorage for medical equipment base plates.
 - 12. Furring strips and point of anchorage for interior finish.
 - 13. Oxygen Sensor.
 - 14. Coordination of other building and mechanical trades, including MRI equipment supplier.
 - 15. Coordination with magnetic shielding.
 - 16. System testing.
 - 17. Provision of phased installation of the MRI magnet access panel/door.
 - 18. Provision of unit costs to add/delete electrical RF filters and pneumatic wave guide components to project.
- B. Related Activities: Work required by other trades is not included in this section. The following items shall be provided by other contractors and be coordinated with the R.F. shielding manufacturer.
 - 1. Site access.
 - 2. Material and equipment staging area.
 - 3. All electrical connections to the R.F. filters, ground connection and wiring inside shielded enclosure.
 - 4. Any ductwork to and from the R.F. penetrations.
 - 5. Field painting and/or any other final finishes.
 - 6. Any general construction work in connection with conventional construction enveloping the shielded enclosure and/or preparing surfaces to receive combination shielded enclosure.
 - 7. Any imaging equipment filters, penetration panel, or installation of this equipment.

1.02 RELATED SECTIONS

- A. Section 01 5000 - Temporary Facilities and Controls: Site access and material/equipment staging areas.
- B. Section 05 5000 - Metal Fabrications: Unistrut support members for RF ceiling support.
- C. Section 08 7100 - Door Hardware: Cylinders for doors in this section.
- D. Section 09 2216 - Non-Structural Metal Framing: Interior framing.
- E. Section 09 5100 - Suspended Acoustical Ceilings: Aluminum ceiling grid.

- F. Section 09 5300 - Acoustical Insulation.
- G. Section 13 4943 - MRI Magnetic Shielding.
- H. Section 21 0000 - Supplementary Fire Suppression General Conditions.
- I. Section 23 0000 - Supplementary Mechanical General Conditions
- J. Section 26 0000 - Supplementary Electrical General Conditions.

1.03 REFERENCES

- A. ASTM E84 - Test Method for Surface Burning Characteristics of Building materials, 2016.
- B. ASTM E90 - Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements, 2009.
- C. ASTM E413 - Classification for Rating Sound Insulation, 2016.
- D. ASTM F1869 - Test Method for Measuring Moisture Vapor Emission Rate of Concrete Sub Floor Using Anhydrous Calcium Chloride, 2016a.
- E. IEEE-299 - (As modified for MRI Testing) Methods of attenuating measurements for Electromagnetic Shielding Enclosures for Electrical Test Purposes.
- F. FS QQ-S-571E(2) - Solder, Tin Alloy; Tin-lead Alloy; and Lead Alloy.
- G. FS QQ-B-626D - Brass, Leaded and Non-leaded: Rod, Shapes, Forgings, and Flat Products with Finished Edges (Bar and Strip).
- H. FS NN-P-530E - Plywood, Flat Panel.
- I. FS MM-L-751H - Lumber, Softwood.
- J. MIL-STD-285 - (as modified for MRI Testing) Methods of Attenuation Measurement for Electromagnetic Shielding Enclosures for Electronic Test Purposes.
- K. MIL-STD-220A - Method of Insertion Loss Measurements of Radio Frequency Power Line Filters.
- L. UL1283 Standards for Safety-Electromagnetic Interference Filters.

1.04 QUALITY ASSURANCE

- A. The function of the combination assembly is to provide a Radio Frequency Interference free environment with a single point ground and defined magnetic fringe field containment. For this purpose, the interference free environment must meet the minimum functional requirements listed below.
 - 1. Magnetic field attenuation: 90 dB between 10 KHz and 100 MHz (Decibel rating: 90 db)
 - 2. Electrical field attenuation: 100 dB between 10 KHz and 100 MHz (Decibel rating: 100 db).
 - 3. Planewave attenuation: 100 dB between 10 MHz and 100 MHz (Decibel rating: 100 db).
 - 4. Isolation resistance: 1000 ohms minimum.
- B. Use of Dissimilar Metals
 - 1. The use of dissimilar metals shall not be allowed.
 - a. RF shielding medium shall display an anodic voltage differential index of less than 0.40 volts and a cathodic group number of 1 (0.00 volts) to 9 (0.40 volts).
 - b. Construct shielding system with proper materials so that ionic conduction across joints and RF seams shall be less than 0.10 volts.
 - 2. Use of the following in manufacture and installation of shielded enclosure shall be permitted.
 - a. Bronze or brass flame sprayed treatment of steel or aluminum RF contact surfaces.
- C. System to provide attenuation for the following systems:
 - 1. Siemens Medical Systems Magnetom Prisma 3.0T.

- D. Manufacturer Qualifications
 - 1. Shall have been engaged in manufacture and installation of radio frequency shielded enclosures of like size and complexity of that required for this Project for a period of not less than eight (8) years.
 - 2. Shall demonstrate if required, that all components of required enclosure are manufactured directly by manufacturer within manufacturer's own plants.
 - 3. Shall demonstrate that no parts, subassemblies, components or systems are remanufactured, reconditioned, or used.
 - 4. Shall have within his direct employment experienced and properly equipped installation and erection crews.
 - 5. Shall have within his direct employ experienced and properly equipped engineering, drafting, and project management departments.
- E. Pre-Construction Conference: The Contractor shall arrange a conference to be attended by the Owner, the Architect, the Contractor, the manufacturer's representative and approved installer, and all subcontractors having work associated with the construction of R.F. shielding. All participants shall have a minimum of one week's advance notice of conference and all listed above shall be in attendance. Requirements of work, preparation, storage, delivery, handling, protective measures, coordination and interface with related work, and phased installation of MRI magnet access shall be discussed.

1.05 SUBMITTALS

- A. See Special Conditions - Submittals, for submittal procedures.
- B. Shop drawings shall be submitted for approval prior to fabrication. Shop drawings shall reflect the typical enclosure floor plan, ceiling plan, elevations, typical construction, sections, details, locations of miscellaneous penetrations and any other conditions, which will affect the shielding enclosure.
- C. Test Reports (Upon Completion)
 - 1. RF Qualification Test
 - 2. RF Acceptance Test
 - 3. Ground Isolation Monitoring Test
- D. Operation and Maintenance Instructions, Including Parts List:
 - 1. The instructions shall include complete procedure necessary to operate and maintain the enclosures, including maintenance procedure, trouble shooting, assembly, and disassembly of the rooms.
 - 2. Parts list shall include spare parts recommended by manufacturer to insure efficient operation of the enclosure for one year, normal operation, following expiration of the warranty period.

1.06 WARRANTY

- A. Enclosure shall be warranted against defective materials and workmanship and to retain the specified radio frequency shielding characteristics for a period of five years from date of acceptance test, including the filters and door system.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. The manufacturer shall have a minimum of eight years experience in the manufacture and installation of RFI shielded enclosures with references from imaging system vendors, architectural/engineering firms and general contractors. Same as Braden Shielding Systems, 9260 Broken Arrow Expressway, Tulsa, Oklahoma 74145, (918) 624-2888; IMEDCO America Ltd., 1730 E. Pleasant Street, Noblesville, IN 46060 (317) 219-3562; ETS / Lindgren, Inc., 17915 East North 95th Street, Owasso, OK 74055, (918) 376-2800.

2.02 PERFORMANCE CRITERIA

- A. Provide completed R.F. shielded envelope installed within the facility to meet the performance requirements specified, including the following:
1. Provide structural engineering for self-supporting shielding enclosure based on design criteria established on Contract Documents including all miscellaneous support and connections.
 2. The R.F. enclosure shall be electronically isolated from the building system.
 - a. RF Shield Wall Assembly: The shield system wall panels shall be vertically self-supported and structurally independent from the parent building. The wall assembly shall allow for the addition of customer provided interior finishes without penetration of the attenuating materials.
 - b. RF Shield Ceiling Assembly: The RF shield assembly shall be supported from customer provided structural assemblies and provide interior surfaces that allow for customer connections of interior finishes and utilities without penetration of the attenuating materials. RF ceiling supports shall employ RF competent fasteners.
 3. The RF floor system be monolithic floor system.
 - a. Epoxy Grout Coating: Over-coat copper membrane with an epoxy grout chemically cured to a minimum 5,000 psi bearing. Install grout underlayment to a minimum ½-inch thickness over entire exam room surface. Grout coating shall not delaminate and must withstand the direct loading of the magnet cryostat and patient table.
 4. Acoustically rated R.F. door units including frames and hardware with plastic laminate finish.
 5. Removable access panels for magnet delivery and removal (at Entrance Door Assembly).
 6. High visibility acoustically rated R.F. view window.
 7. HVAC supply, return and exhaust systems shall have waveguide type R.F. air vents for systems.
 8. Electrical and communication services shall have UL approved R.F. attenuation filters.
 9. Pipes penetrating the shield shall have necessary wave guide type shielded fittings.
 10. Single point enclosure system ground.
 11. Cavity wall type construction shall be provided for concealed electrical conduit and related equipment as required in other specification sections.
 12. Provision and installation of cryogenic exhaust wave guide and isolation adapter.
 13. Provision of oxygen alarm monitoring system.

2.03 MATERIALS

- A. Shielding Material (Walls/Ceiling): Galvanized QC1020 steel, 28 gauge minimum. G-90 zinc coated conforming to the galvanic requirements of Quality Assurance paragraph (actual thickness depends on magnet type).
1. Panels are constructed of flat 28 gauge minimum (actual thickness depends on magnet type) QC1020 steel laminated to each side of a ¾" structural core of either plywood or hardboard. Panels have a flame spread rating of less than 25 when tested according to ASTM E 84
 2. Flat Steel sheet is ASTM A 25 and ASTM A 526 with G-90 coating, minimum 28 gauge, zinc-coated.
 3. Plywood is PS 51 for exterior, sound grade hardware, Type 1.
 4. Hardboard is PS 58 for standard type hardboard.
 5. Adhesive for laminating steel sheets to structural core is waterproof and maintains a permanent bond for the lifetime of the enclosures.
- B. Shielded Material (Floor):
1. Shielded material shall be annealed, pure copper.

- C. Design RF seam and joint construction methods to provide the maximum in shield conductivity, low impedance, RF attenuation, and reduction of eddy current generation at RF seams and joints.
1. Framing-Joining Systems: The panels shall be joined and supported by specially designed members that clamp the edges of the panels and provide continuous, uniform, and constant pressure contact against the shielding elements of the panels. The wall shall be self-supporting from the floor to the ceiling with no bracing. Deflection of walls under static load of 75 pounds applied normal to the wall surface at any point along the framing member shall not exceed 1/250 of the span between supports. Ceiling shall be supported by either adjustable, non-conductive, isolated hangers from the structural ceiling above or an independent structural support system. Ceiling shall be designed to have a deflection under total weight of their construction, including ceiling finish, fire sprinkler, cable trays, electrical devices and lighting, of not more than 1/270 of the span.
 2. Channels: The framing-joining system members shall consist of 1/8-inch inquire zinc-plated steel channels have in minimum 5/8" overlap along each side of the contacting surface. Screw fasteners of either zinc-plated or cadmium-plated steel, self-threaded, size 1/4 - 20 shall be provided to complete the assembly. Fasteners shall be heat-treated and hardened with minimum tensile strength of 135,000 psi. At all corner intersections or walls, floor or ceiling, a one-piece factory pre-welded corner section shall be provided.
- D. Primary Enclosure: Vertical walls, floor and ceiling, made integral with RF floor system. The shielded enclosure shall be of the demountable prefabricated panel type, capable of being erected, disassembled and re-erected entirely from its interior without special tools. Screws shall be tightened with a properly calibrated adjustable torque wrench, so that equal torque can be set on all screws (proper torque values will be in the range of 90 inch-pounds).
- E. Monolithic Floor System:
1. Basic System: Provide an all copper, monolithic, RF floor membrane. RF solder weld all copper membrane seams.
 2. Electrical Isolation: Provide electrical isolation of enclosure and RF floor system by use of a two-part, thermosetting resin bonded directly to concrete floor substrate. Use of Masonite, other pressed wood materials, plastic sheet or tar paper sheet goods for electrical isolation or as a moisture barrier is not acceptable.
 3. Moisture Barrier: ARDEX MC RAPID shall be installed only over concrete surfaces that have been properly mechanically prepared to a minimum surface profile of ICRI CSP #3 and which have an RH value of 98% or less when measured in accordance with ASTM F2170 and which has no signs of visible water.
 4. Membrane Adhesive: Bond monolithic copper membrane to dielectric barrier with a two part adhesive resin compatible with both the copper and dielectric barrier.
 5. Epoxy Grout Coating: Over-coat copper membrane with an epoxy grout chemically cured to a minimum 5,000 psi bearing. Install grout underlayment to a minimum 5/8-inch thickness over entire treatment room surface. Grout coating shall not delaminate and must withstand the direct loading of the magnet cryostat and patient table.
 6. Curing of New Concrete Structural Slab: Contractor will be required to install a topically applied moisture barrier system prior to installation of RF floor system. Moisture barrier system to be compatible with RF System manufacturer's dielectric barrier.
 7. Parent slab for monolithic floor system to meet the following criteria:
 - a. Slab must be clean down to the bare surface by surface shot blast surface profile of (3) CSP3.
 - b. Do not apply any concrete sealer.
 - c. The parent slab must be level to at least the minimum requirements of the magnet manufacturer or as stated in the RF shield submittal plans.

- d. Do not use K-15 floor leveling compound to bring the parent slab into specification for levelness.
 - e. The total moisture content of the parent slab cannot exceed 95% relative humidity.
- F. Pneumatic (AS-2) RF Shielded Patient Entry Door: The shield system door shall be visually similar to conventional interior doors and shall utilize a retractable RF sealing system with key pad control access. The perimeter R.F. door seal shall be adjustable or replaceable. This seal shall be rated a minimum of 50,000 cycles without loss of R.F. attenuation and without adjustment and/or replacement. Door hardware shall consist of the following:
1. Material: The door shall be manufactured of all 304 stainless steel construction inclusive of both the door leaf and jamb assemblies.
 2. Acoustical Door Rating: The door assembly shall have a minimum STC-44 sound rating as certified by a recognized acoustic testing lab.
 3. The door shall have optional remote activation/deactivation capabilities.
 4. RF Sealing Mechanism: Shall consist of a smooth surface, continuous, phosphor-bronze (beryllium/copper alloys are forbidden) strip running the full length of each edge of the RF door jamb and bottom edge of the door leaf. Seals shall be activated utilizing piston driven actuators. (Bladder systems are not acceptable.)
 5. Failsafe Feature: Door shall employ fail-safe unlatching. Upon loss of any one power service, the door will revert to an unsealed condition. The door shall have optional remote activation/deactivation capabilities.
 6. Door Latch: ADA compliant standard lever action passage latch set with Schlage integral keyed security lock outside and turn push button inside.
 7. Door Leaf Hinges: Minimum 4-1/2 inch brass or stainless steel, fully mortised, with minimum of two ball-bearing swing joints per hinge. Provide minimum of three hinges per leaf.
 8. Door Threshold: The door threshold shall be flat without taper with a maximum height from the MRI room's parent slab depression of 5/8" (16mm).
 9. MRI Interlock: Provide a RF door interlock switch. (Electrical interconnections and mounting by Division 16 subcontractor.)
 10. Keypad entry hardware including auxiliary outputs for fire alarm and security access. Provide remote release device to be located at MRI control console.
 11. Door finish shall be high quality plastic laminate, custom color as selected by Architect.
 12. Provide a low noise, reciprocating piston, 120vac electric air compressor capable of 120-psi output pressure with on-board receiver tank. Provide coalescent air filter and automatic drain system for condensate water.
 13. SVIP Intravenous Tubing Pass-Through System:
 - a. All 304, austenitic, stainless steel.
 - b. 0.69" ID Stainless Steel Tubular line port.
 - c. Available for both left and right hinged doors.
 - d. Factory installed integrated into RF door frame.
 - e. Line capacity: Minimum 7 standard IV line capacity.
- G. RF Shielded Patient View Window: Construct acoustically rated RF shielded view window assembly utilizing an aluminum extrusion of an engineered shape to affix RF attenuating screens and provide a means of securing double-sided glazing. Threat contact surface of extrusion with brass flame spray.
1. RF Performance: Provide a proven RF seal design that is easily maintained and serviced. RF window frame and seal assembly shall maintain a shielding effectiveness equal to that of the shielded enclosure.
 2. Construct RF screen of a double layer of 304 stainless steel and place layers in a horizontal orientation to each other so that resultant distortion of viewed image through RF shielded window approaches zero.

3. Stain the visible area of RF screens pure black in color for optimum image visibility.
 4. The RF window system shall provide minimum ASTM-STC 40 rating.
- H. HVAC air vents shall be of the waveguide below cut-off type. Vents shall be roughly 1" aluminum cells by 4" deep welded cells with roughly 1 1/2" welded frame with shielding effectiveness equal to the effectiveness of the R.F. shield. The waveguide type R.F. air vent filters shall be designed to provide proper airflow for temperature control and ventilation and shall maintain shield effectiveness. Reference mechanical documents for quantities. Provide interior and exterior dielectric collars for attachment of ventilation ductwork.
- I. Cryogenic Gas Exhaust Wave-Guide Vent: Wave guide below cutoff type, size as required by MRI system manufacturer. Construct cryogenic wave guide vent of suitable material to maintain a shielding effectiveness equal to that of shielded enclosure, and to resist structural failure during a magnet quench event. An insulated break in the pipe on the outside of the shield shall be provided by the shielding manufacturer.
- J. RFI Ceiling Relief Panels shall be fabricated similar to HVAC air vents. Locate minimum of one (1) 24x24 unit in RF ceiling construction near entrance door to RF enclosure.
- K. EMI Rated Power Line and Signal Electrical Filters: RF shielded electrical filters shall provide an insertion loss as specified within MIL-STD 220-A and maintain the shielding effectiveness equal to that of the shielded enclosure. Provide an EMI filter for each electrical conductor that penetrates the enclosure, including neutral conductors. UL certification will be required for all power line filters.
1. Reference RF Shielding documents for quantity and sizes.
 2. Coordinate lighting filters with CM/Electrical Contractor.
- L. Mechanical Pipe Penetrations: Wave-guide below cutoff type. Construct pipe penetrations of a material suitable to conditions of service on which it is installed, and to maintain shielding effectiveness equal to that of the shielded enclosure.
1. All Mechanical Pipe Penetration services entering and routing within the RF enclosure shall be installed by the customers; contractor/subcontractor using RF suppliers/magnet manufacturers approved techniques.
- M. Medical Gas Piping Systems: Provide a medical gas panel that complies with NFPA chapter 99C-42 and of the wave-guide below cutoff type. Each individual medical gas line shall be medically clean type K copper and brass, without seams, through the provided pipe wave-guides. Provide a brass or copper mechanical coupling between the exterior end of the threaded gas line wave-guide that the pass through copper pipe.
- N. Grounding Conductor Terminal: Provide a single point ground conductor terminal using a brass stud and copper bus bar, common to both interior and exterior of enclosure. Locate terminal as close as possible to MRI penetration panel and to EMI power line filters.
1. All ground conductors entering and routing within the RF enclosure shall be installed by the customers' contractor/subcontractor using RF suppliers/magnet manufacturers approved techniques.
 2. RF shall be grounded prior to the connection of electrical services to the EMI power and/or signal filters.
- O. Oxygen Alarm: Provide oxygen monitoring system including but not limited to zirconium oxide sensor, alarm panel with air draw flow pump and on board CPU, interconnect tubing, remote horn alert and strobe, and interface module to HVAC system.
1. Same as ETS/Lindgren's, "OMS Sample Draw Oxygen Monitoring System".

PART 3 PRODUCTS

3.01 INSPECTION

- A. Before system installation, verify the on-site conditions affecting work of this section. Report any discrepancies between building drawings, shop drawings, and field conditions to the Architect and General Contractor prior to commencing installation.

3.02 INSTALLATION

- A. Installation shall be performed by or under the supervision of the shield vendor.
- B. Floor: Meet the requirements of the materials section.
- C. All panels shall be laid in a straight line with true level and even surfaces, and the joints shall be in alignment. Exposed surfaces shall be thoroughly cleaned of all dirt, finger marks and foreign matter resulting from handling or installation, and all areas shall be left free of defects.
- D. Coordinate installation of all Mechanical and Electrical trades.
- E. Coordinate installation with magnetic shielding.
- F. Coordinate installation of MRI/magnet access, RF room completion, room finishes completion and final RF testing.

3.03 TESTS

- A. During construction of combination shielded enclosure, ground isolation shall be monitored at all times to assure that the shielded enclosure is isolated from handling or installation, and all areas shall be left free of defects.
- B. Test enclosure in accordance with IEEE-299, as modified for MR system installation. Demonstrate the required attenuation as detailed under Performance paragraph.
- C. Qualification Testing: Perform immediately after completion of the enclosure and prior to installation of architectural surfaces within or outside the enclosure. Make no trade connections to enclosure until successful completion of test process.
 - 1. Note requirement for initial RF envelope and coordination with MRI magnet access.
 - 2. The Owner, General Subcontractor, and the MR Manufacturer will witness the test procedure. Notify the contracting party that the RF test is to occur.
 - 3. Furnish a certification of compliance to the General Contractor.
- D. Acceptance Testing: Perform immediately after installation of the selected MRI assembly and closure of the RF entrance panel.
 - 1. The Owner, General Contractor, and MR Manufacturer will witness test procedure.
 - 2. Furnish a written test report to the General Contractor.
- E. A second "qualification" R.F. test will be performed after the treatment room construction is complete and the imaging/treatment equipment is in place. Test to be performed before the magnetic equipment is "ramped" up to operating magnetic field. Provide written report of test results.
- F. Ground Isolation Monitoring: Monitor ground isolation during entire phase of construction for a minimum of 1,000 ohms above earth potential. Immediately correct deficiencies found that are the result of a fault condition caused by the enclosure supplier. Immediately report deficiencies found to be caused by other trades.
 - 1. Provide an adjustable audio and visual ground isolation device for continuous monitoring of the RF enclosures ground isolation. Device is to remain with the enclosure for follow up monitoring by the general subcontractor.
 - 2. Furnish a certification of compliance to the contracting party.

- G. Oxygen Alarm: Perform testing on oxygen monitoring system and its ability to activate exhaust fan upon the depletion of oxygen level in the room and reset itself when oxygen levels are back to acceptable levels. Contractor to coordinate with purge exhaust sequence of operation on Mechanical Drawings.

END OF SECTION 13 4942

SECTION 20 0800
SEISMIC PROTECTION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to the work of this Section.

1.02 APPLICABILITY

- A. Seismic supports and restraints shall be provided for all Life Safety and Hazardous or Flammable systems. The following are defined as Life Safety and Hazardous or Flammable:
1. Fire protection equipment and systems.
 2. Fire suppression piping.
 3. Communication and fire alarm systems.
- B. In addition to the above, seismic supports and restraints shall be provided for all of the following systems: (add or remove trades equipment based on project scope of work and seismic bracing requirements).
1. Electrical bus ducts and primary cable systems.
 2. Electrical motor control centers, motor control devices, switchgear, transformers, and unit substations.
 3. Piping systems.
 4. HVAC ducts.
 5. Electrical panelboards.
 6. Lighting fixtures.

1.03 EXEMPTIONS

- A. The following mechanical and electrical components are exempt from the requirements of this Section:
1. MEP components that were existing prior to beginning of construction of this project and which are not disturbed during the course of this work, are exempt.
 2. Piping and conduit are exempt if the entire run is suspended from 3/8" or 0.5" in diameter rod hangers 12-inches or less in length from the top of the pipe to the supporting structure and the total weight supported by any single rod is 50 lb or less, and if the hangers are sufficient to avoid significant bending of the hangers and their connections.
 3. Piping constructed of steel, copper, ductile iron, aluminum, or plastic, of nominal diameter 1-inch and smaller, are exempt.
 4. Conduit constructed of steel, copper, ductile iron, aluminum, or plastic, of nominal diameter 2.5-inch and smaller, are exempt.
 5. If not part of Life Safety and Hazardous or Flammable systems, HVAC ducts are exempt if the entire duct run is suspended from 3/8" or 0.5" in diameter rod hangers 12 inches or less in length from the top of the duct to the supporting structure and the total weight supported by any single rod is 50 lb or less, and if the hangers are sufficient to avoid significant bending of the hangers and their connections.
 6. If not part of Life Safety and Hazardous or Flammable systems, HVAC ducts are exempt if the entire duct run consists of ducts less than 6 square feet in cross-sectional area or weight 20 lb/ft or less.
- B. There are no further exemptions allowed for Life Safety and Hazardous or Flammable components or systems as defined in the "Applicability" subsection above.
- C. For other than Life Safety and Hazardous or Flammable systems, the following mechanical and electrical components are exempt from the requirements of this Section:

1. If not part of Life Safety and Hazardous or Flammable systems, MEP components weighing less than 20 pounds are exempt if flexible connections are provided between the components and associated ducts, pipes, or conduit.
 2. If not part of Life Safety and Hazardous or Flammable systems, MEP components weighing less than 400 pounds are exempt if flexible connections are provided between the components and associated ducts, pipes, or conduit, and if the component is mounted at 48 inches or less above finished floor level.
 3. If not part of Life Safety and Hazardous or Flammable systems, piping constructed of steel, copper, ductile iron, aluminum, or plastic, of nominal diameter 3-inch and smaller, is exempt.
 4. If not part of Life Safety and Hazardous or Flammable systems, conduit constructed of steel, copper, ductile iron, aluminum, or plastic, of nominal diameter 2.5-inch and smaller, is exempt.
 5. If not part of Life Safety and Hazardous or Flammable systems, electrical conduits, cable trays, and bus ducts are exempt provided none of the following apply:
 - a. Supports are cantilevered up from the floor.
 - b. Supports are constructed as rigid welded frames.
 - c. Supports include bracing to limit deflection.
 - d. Attachments into concrete utilize nonexpanding inserts, shot pins, or cast iron embedments or attachments utilizing spot welds, plug welds, or minimum size welds (as defined in AISC LRFD).
- D. Any otherwise-exempt MEP component, whose failure in an earthquake would potentially damage a non-exempt component, is non-exempt. Example: An exempt storm drainpipe mounted above a non-exempt natural-gas pipe could fall and rupture the gas pipe. Therefore, the storm drainpipe must be treated as non-exempt.

1.04 SUMMARY

- A. Description of Work: The purpose of this section is to define seismic restraint requirements for mechanical and electrical systems, equipment, and devices, hereinafter referred to as components.
- B. This Section does not specify seismic force resisting systems for building structures and structural elements, which are addressed in Divisions 03 through 06.
- C. The requirements for seismic protection specified herein are in addition to any requirements for support and/or seismic protection specified in other sections of these specifications.
- D. The Contractor shall be responsible for developing details to provide proper support of equipment and devices in accordance with the requirements specified herein.
- E. The Contractor shall not proceed with installation of equipment nor seismic protection system until all applicable submittals required by this section have been completed.
- F. This section includes the following:
 1. Applicable Code.
 2. Project-specific Code Coefficients
 3. Rigid Support Items.
 4. Non-rigid Support Items.
 5. Sway Braces.
 6. Anchors, Bolts and Clamps.
 7. Restraining Cables.
 8. Seismic Snubbers.
 9. Installation Requirements.
- G. Related sections: The following sections contain requirements that relate to this section:

1. Division 05 Section "Metal Fabrications" for materials to anchor equipment piping to building structure.
2. Division 07 Section "Roof Accessories" for roof equipment supports.
3. Division 09 Sections "Interior Painting" and/or "Exterior Painting" for field-applied painting requirements.
4. Division 23 Section "Basic Mechanical Materials and Methods" for general mechanical requirements.
5. Division 23 Section "Hangers and Supports" for piping and equipment supports.
6. Division 23 Section "Mechanical Vibration Isolation" for vibration-isolation hangers, supports and flexible connectors.
7. Division 23 Section "Mechanical Insulation" for pipe, duct, and equipment insulation.
8. Division 26 Section "Common Work Results for Electrical" for general electrical requirements.
9. All Division 21 to 28 Sections for mechanical and electrical equipment and systems requiring seismic protection.

1.05 DEFINITIONS

- A. Terminology used in this section is defined in ASCE/SEI 7-16: *Minimum Design Loads for Buildings and Other Structures*, as issued by the American Society of Civil Engineers, 2017; Reston, Virginia.

1.06 PERFORMANCE REQUIREMENTS

- A. This facility is designated as Risk Category III.
- B. The spectral response acceleration at short periods, S_s , shall be taken as 0.48g.
- C. The spectral response acceleration at one-second period, S_1 , shall be taken as 0.18g.
- D. This facility site is designated as Site Class Definition D.
- E. The Site Coefficients, F_a shall be taken as 1.42 and F_v shall be taken as 2.08.
- F. SDS, the Five-Percent damped design spectral response acceleration at short periods, shall be taken as $SDS = 0.4$.
- G. SDI, the Five-Percent damped design spectral response acceleration at one-second period, shall be taken as $SDI = 0.25$.
- H. This facility is designated as Seismic Design Category D.
- I. The horizontal seismic force on a given component shall be noted as F_p . The seismic force F_p shall be applied at the center of gravity, independently longitudinally and laterally in combination with service loads associated with the component. The following equation shall be utilized individually on every component to determine F_p :
 1. $F_p = 0.64 \times I_p \times W_p$ where
 - a. I_p = Component Importance Factor.
 - b. W_p = Component Operating Weight in pounds.
 2. In lieu of the above equation, a much more detailed calculation involving Equation 13.3-1 of ASCE 7-16 and its related Tables, which may yield somewhat lower results for F_p , may be utilized. If this option is selected, complete details of all such calculations shall be submitted as required under "Submittals" below.
- J. The vertical seismic force on a given component shall be taken as $0.08 \times W_p$ and shall be determined individually for every component. This vertical force shall be applied at the center of gravity of the component, in either vertical direction, and shall be considered concurrent with the horizontal force determined above.

1.07 SUBMITTALS

- A. The Engineer shall receive one copy of all submittal data supplied to the Owner as required in this specification. It is the responsibility of the Contractor to provide seismic protection as outlined herein. Receipt by the Engineer of a copy of the submittals 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 calculations submitted and equipment proposed.
- B. Prior to installation of equipment and devices requiring seismic restraints, the Contractor shall submit required documentation and details at the shop drawing review stage to the Owner. Submit the following in accordance with conditions of contract and Division 01 specification sections.
- C. Product data: Include installation details and instructions for each type of seismic support and restraint. Submit equipment support and restraint schedule showing size, location, and features for each required support and restraint.
- D. Product certificates: Signed by the manufacturer of seismic supports and restraints certifying that their products meet the specified requirements.
- E. Shop Drawings: Calculations and Drawings signed and sealed by a qualified professional engineer registered to practice in the State of Missouri, shall be provided for the installation details of each piece of equipment. Include the following:
 - 1. Design Calculations: Calculate requirements for selecting seismic restraints. Exception: Certified and stamped calculations are not required for seismic-restrained systems which have been pre-approved by OSHPD or comply with ANSI/SMACNA Standard 001-2008 *Seismic Restraint Manual; Guidelines for Mechanical Systems*, as issued by the Sheet Metal and Air Conditioning Contractors National Association, Inc., 2008; Chantilly, Virginia; Third Edition; except where more stringent requirements are described herein. A signed letter on Contractor's letterhead shall be provided as part of the submittal process stating which approved systems are being utilized.
 - 2. Seismic-Restraint Details: Detail fabrication and attachment of seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.
 - 3. Assembly-type shop drawings: For each type of seismic support and restraint, indicate dimensions, weights, required clearances, and methods of assembly of components. Submittal Drawings shall indicate in complete detail size, type, material grade, locations and dimensions; and shall show construction details, reinforcement, anchorage and installation with relation to the building construction. Submittals shall include, but not be limited to sway braces, flexible couplings or joints, resilient type vibration devices, and anchorage of concrete equipment pads to structure.
 - 4. Where seismic anchors and braces for one component must unavoidably be attached to two or more elements of a structure subject to differential movement, such as a wall and a floor or two different floors, submit sealed calculations for relative displacements; including selection of sufficient flexible fittings to accommodate the relative displacement. Examples subject to relative displacement include vertical pipe or conduit risers; or a pump anchored to a floor and rigidly connected to piping anchored to the roof structure above.
- F. Welder certificates: Signed by Contractor certifying that welders comply with requirements specified under "Quality Assurance" Article.
- G. Maintenance data: For seismic supports and restraints for inclusion in Operating and Maintenance Manual specified in Division 01, Division 23 Section "Basic Mechanical Requirements" and Division 26 Section "Common Work Results for Electrical."
- H. Manufacturer Seismic Qualification Certification: Submit certification that all specified equipment will withstand seismic forces identified in "Performance Requirements" Article above. Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 2. 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. Contractor's Acknowledgement of Seismic Responsibility: Submit written contractor's statement of responsibility prior to commencement of the work, acknowledging an awareness of the seismic restraint requirements of the project, that control will be exercised to obtain conformance with the Construction Documents, listing procedures for exercising control over the seismic restraint installation, and identifying the responsible person(s) within their organization.

1.08 QUALITY ASSURANCE

- A. Seismic-restraint devices shall have horizontal and vertical load testing and analysis performed according to OSHPD and shall bear anchorage preapproval "R" number, from OSHPD or another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. 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) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer. Testing and calculations must include both shear and tensile loads and one test or analysis at 45 degrees to the weakest mode.
- B. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code – Steel." Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.09 REFERENCES

- A. Regulatory Requirements: Comply with applicable codes pertaining to product materials and installation of seismic supports and restraints.
- B. Referenced Codes and Standards: All work provided under this section shall comply with the requirements specified herein, and additionally as provided in the following Codes and Standards. In all cases where conflicting requirements are provided within these specifications, Codes and Standards, the most stringent requirement shall apply.
- C. IBC 2021: Comply with the International Building Code Chapters 16 and 17.
- D. ASCE/SEI 7-16: Comply with Minimum Design Loads for Buildings and Other Structures, as issued by the American Society of Civil Engineers, 2017; Reston, Virginia.
- E. NFPA Compliance: Seismic supports and restraints shall comply with NFPA Standard 13 when used as a component of a fire protection system.
- F. UL and FM Compliance: Seismic supports and restraints shall be listed and labeled by UL and FM where used for fire protection piping systems.
- G. ANSI/SMACNA: All seismic restraints for piping and ductwork shall comply with ANSI/SMACNA Standard 001-2008 *Seismic Restraint Manual; Guidelines for Mechanical Systems*, as issued by the Sheet Metal and Air Conditioning Contractors National Association, Inc., 2008; Chantilly, Virginia; Third Edition. A seismic hazard level (SHL) shall be utilized as scheduled below.
1. All Fire Protection/Suppression Piping: SHL - A
 2. All other ductwork not listed above: SHL - B
 3. All other Piping not listed above: SHL - B

- H. ANSI Standards and ASTM Publications: Seismic supports and restraints shall comply with American National Standards Institute, Inc. (ANSI) and the American Society for Testing and Materials (ASTM) Publications.
1. B18.2.1-1981 Square and Hex Bolts and Screws Inch Series
 2. B18.2.2-1972 Square and Hex Nuts (R1983)
 3. A36-84a Structural Steel
 4. A307-86a Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
 5. A325-86a High-Strength Bolts for Structural Steel Joints
 6. A501-84 Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
 7. A576-87 Steel Bars, Carbon, Hot-Wrought, Special Quality
- I. Federal Specification: Seismic supports and restraints shall comply with Federal Specification RR-W-410D for Wire Rope and Strand.

1.10 COORDINATION

1.11 EXTRA MATERIALS

- A. Furnish extra replacement neoprene inserts for all snubbers, which match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following: (add or remove suitable manufacturers, based on project scope of work and bracing requirements)
1. California Dynamics Corp.
 2. Eaton; Cooper, B-Line, and Tolco brands.
 3. Kinetics Noise Control, Inc.
 4. Loos & Co., Inc.
 5. Mason Industries, Inc.
 6. Unistrut Corp.; division of Tyco International, Ltd.
 7. Vibration Eliminator Co., Inc.
 8. Vibro-Acoustics, Inc.
 9. The VMC Group; Amber/Booth, Korfund, and VMC brands.
- B. All seismic restraint devices of any one general group; raceways or suspended equipment, or switchgear or other floor mounted equipment, etc., shall be provided by a single manufacturer.

2.02 MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A36.
- B. Bolts and Nuts: Square and hex bolts and nuts, ANSI B18.2.1 and B18.2.2, SAE Grade 5, and ASTM A307 or A325.
- 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.
- F. 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 E488. Minimum length of eight times diameter.

- G. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless-steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488.
- H. Sway Brace: Material used for members listed in Table I of this specification, except for pipes, shall be structural steel conforming with ASTM A36. Steel pipes shall conform to ASTM A501. Note additional exception below.
 - 1. Contractor's Option: In lieu of utilizing angles, rods, bars or pipes as noted in Table I, U-channel systems consisting of channels, fittings and accessories may be utilized. The u-channel system shall be manufactured as a complete system by one supplier and listed by the manufacturer for use in seismic restraint application. The system shall have the approval of OSHPD. The equipment shall provide multi-directional bracing of electrical conduit, cable tray and mechanical piping/ductwork systems.

2.00 TABLE I

MAXIMUM LENGTH AND ALLOWABLE CONCENTRIC LOADS FOR SWAY BRACES

Type	Size (inches)	Maximum Length*	Allowable Concentric Load* (kips)
Angles	1½ x 1½ x ¼	4'-10"	3.4
	2 x 2 x ¼ 6'-6"	4.6	
	2½ x 2½ x ¼	8'-2"	5.9
	3 x 3 x ¼ 9'-10"	7.1	
Rods	¾	3'-1"	2.2
	7/8	3'-7"	3.0
Pipes (40S)	1	6'-9"	2.4
	1¼	8'-8"	3.3
	1½	10'-1"	3.9
	2	12'-9"	5.3
	2½	15'-4"	8.4
	3	19'-0"	11.0

*Based on the slenderness ratio of 1/r = 200, and load applied concentrically to brace. The tabulated load values include a 33% stress increase as permitted for seismic loads. For non-concentric loading, allowable brace load is to be determined per the AISC Specification for Structural Steel Buildings / ASD 1989.

- I. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Reinforcing steel angle clamped to hanger rod is also acceptable.
- J. Restraining Cables: ASTM A603 galvanized steel aircraft cables of minimum diameter 1/8-inch, with end connections made of steel assemblies that swivel to final installation angle and utilize two clamping bolts for cable engagement. Cables shall conform to Fed. Spec RR-W-410 as follows:

1. Less than 1/8-inch diameter Not Permitted
 2. 1/8-to-5/32-inch diameter Type V, Class 1
 3. 3/16 inch to 5/16 diameter Type V, Class 2
 4. 1/4 inch to 5/8 diameter Type I, Class 2
- K. Resilient Isolation Washers and Bushings: 1-piece, molded, bridge-bearing neoprene complying with AASHTO M 251 and having a durometer of 50, plus or minus 5, with a flat washer face.
- L. Seismic Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
 2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
 3. Maximum ¼-inch (6-mm) air gap, and minimum ¼-inch- (6-mm-) thick resilient cushion.
- M. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.
- N. Flexible Couplings: Flexible couplings shall have same pressure ratings as adjoining pipe.
- O. Cement Grout: Portland cement (ASTM C150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C404, Size No. 2). Mix ratio shall be 1.0-part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration. P. Non-shrink, Nonmetallic Grout: ASTM C1107, Grade B.
1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
 3. Packaging: Premixed and factory packaged.
- P. Galvanizing Repair Paint: High-zinc-dust-content paint, with dry film containing not less than 94 percent zinc dust by weight.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine Areas and equipment to receive

3.02 SEISMIC PROTECTION, GENERAL

- A. Attachments and supports for mechanical and electrical systems and components shall be designed to resist the seismic forces specified herein.
- B. Mechanical and electrical systems and components shall be designed by their manufacturer to consider dynamic effects of the equipment and its contents. Design, selection, and installation of seismic bracing for mechanical and electrical systems and components shall account for interaction between equipment and supporting structures, and the effect imposed by attached utility or service lines and shall ensure that impact between components is avoided during a seismic event.
- C. Anchorage: Install seismic supports and restraints complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
1. Friction resulting from gravity loads shall not be considered to provide resistance to seismic loads.
 2. All bolts, including fasteners and anchor bolts, used for attachment of anchors to components and to structure shall be sized for the seismic forces described in Part I but shall not be less than ½-inch diameter in any case.
 3. Powder-driven fasteners and shot pins shall not be permitted in tension load applications.

4. Expansion anchors, other than undercut expansion anchors, shall not be permitted to anchor non-vibration isolated equipment rated over 10 horsepower.
 5. Anchorage Embedment Depth: Not less than eight times the anchorage diameter.
 6. Anchorage Edge Distance: Place anchorage not less than ten times the anchorage diameter from edge of concrete housekeeping pad.
- D. Base-Mounted Equipment: Anchor equipment to concrete base according to supported equipment manufacturer's written instructions for seismic forces at Project site.
1. Concrete equipment pads shall be anchored to the supporting structure as required to resist the seismic loads specified herein. Anchorage shall adequately distribute loads to the elements of the supporting structure; coordinate with building structural engineer if required. Anchorage devices may consist of either cast-in-place or drilled-in and epoxy grouted reinforcing steel dowels. Unless otherwise indicated, install dowel rods to connect concrete base to concrete floor on 18-inch (450-mm) centers around the full perimeter of the base.
 2. All floor or pad mounted equipment shall be anchored with cast-in-place anchor bolts, expansion bolts or epoxy bolts. For vibratory equipment, the nuts shall be secured against loosening by either installing double nuts, tack welding single nut to bolt or scoring bolt threads.
 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base and anchor into structural concrete floor.
 4. Place and secure anchorage devices. Use Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 7. Cast-in-place concrete materials and placement requirements are specified in Division 03.
- E. Resilient Vibration Isolation Devices: Selection of anchor bolts for vibration isolation devices and/or snubbers to equipment base and foundations shall follow the same procedure as for base mounted equipment in subsection above, except that the seismic force found in Part 1 shall be doubled for the purpose of selecting isolation devices, anchorage, and snubbers.
1. Vibration Isolation Devices are suitable for seismic restraint provided the vertical and horizontal seismic forces are within the limits designed into the device.
 2. Resilient and Spring-Type Vibration Devices: Vibration isolation devices shall be selected so that the maximum movement of equipment from the static deflection point shall be 0.5 inches.
 3. Multi-directional Seismic Snubbers: If vibration isolators are required, then multi-directional seismic snubbers employing elastomeric pads shall be installed on all vibration isolated equipment. These snubbers shall provide 0.25-inches free vertical and horizontal movement from the static deflection point. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure. Snubber medium shall consist of viscoelastic or other impact-limiting material arranged around a flanged steel trunnion so both horizontal and vertical overturning forces are resisted by the snubber medium.
 4. Install resilient bolt isolation washers on equipment anchor bolts.
 5. Do not short-circuit vibration isolation device with rigid connection directly to structure.
- F. Equipment Sway Bracing: Required for all items supported from overhead structures. Braces shall consist of angles, rods, bars, pipes, cables, or factory fabricated U-channel systems and secured at both ends with not less than ½-inch bolts. Braces shall conform to Table 1, or as recommended by U-channel systems fabricator. Bracing shall be provided in two planes of directions, 90 degrees apart, for each item of equipment. Details of all equipment bracing shall be submitted.
1. In lieu of bracing with vertical supports, these items may be supported with hangers inclined at 45 degrees directed up and radially away from equipment and oriented symmetrically in 90-degree intervals on the horizontal plane, bisecting the angles of each corner of the

equipment, provided that supporting members are properly sized to support operating weight of equipment when hangers are inclined at a 45-degree angle.

2. Exception: Components mounted in line with duct systems, and which weigh less than 75 pounds, do not require dedicated equipment sway bracing. Instead, such components shall be considered a part of the duct system itself and braced as such.

3.03 PIPES AND DUCTS

- A. General: Select and install restraints for piping and ductwork in complete and strict accordance with ANSI/SMACNA Standard 001-2008 *Seismic Restraint Manual; Guidelines for Mechanical Systems*, as issued by the Sheet Metal and Air Conditioning Contractors National Association, Inc., 2008; Chantilly, Virginia; Third Edition; except where more stringent requirements are described herein.
- B. Fire protection sprinkler systems shall be seismically braced in accordance with NFPA 13; however, the seismic force calculated per NFPA 13, when multiplied by 1.4, shall not be less than that required by this Specification.
- C. Conduit: Restraints for piping shall also apply to conduit.
- D. Transverse Sway Bracing: Transverse sway bracing shall be provided at each horizontal turn of 45 degrees or more, at the end of each pipe/duct run, and otherwise at regular intervals spaced no further than required by the above Standard. Walls which ducts penetrate may be considered transverse braces. Sway bracing shall be provided at closer intervals if so recommended by U-channel manufacturer when using U-channel systems.
- E. Longitudinal Sway Bracing: Longitudinal sway bracing shall be provided at regular intervals spaced no further than required by the above Standard. Transverse bracing for one pipe/duct section may also act as longitudinal bracing for a pipe/duct section connected perpendicular to it, if the bracing is installed within 4 feet of the intersection, and if it is sized for the larger pipe/duct. Sway bracing shall be provided at closer intervals if so, recommended by U-channel manufacturer when using U-channel systems.
- F. All equipment installed in line with ductwork, including but not limited to fans, humidifiers, heat exchangers, air terminal units, etc., and which have an operating weight greater than 75 pounds, shall be supported and sway braced independently of the duct system. Appurtenances lighter than 75 pounds, including but not limited to diffusers, dampers, louvers, grilles, etc., shall be positively attached to the ducts with mechanical fasteners.
- G. Anchor Rods, Angles, and Bars: Anchor rods, angles, and bars shall be bolted to either pipe clamps or pipe flanges at one end and cast-in-place concrete or masonry insert or clip angles bolted to the steel structure on the other end. Rods shall be solid metal or pipe as required.
- H. Restraining Cables: Install restraining cables slightly slack. Install cables so they do not bend across sharp edges of adjacent equipment or building structure.
- I. Hanger Rod Reinforcement: Install steel angles or channel, sized to prevent buckling, clamped with ductile-iron clamps to hanger rods for trapeze and individual pipe and equipment hangers where required. Do not weld angles to rods.
- J. Clamps: Clamps on uninsulated pipes shall be applied directly to pipes. Insulated piping shall have clamps applied over insulation vapor barrier with high-density inserts and metal protection shields under each clamp. Vapor barrier shall not be punctured. At trapeze anchor locations, shackle or clamp piping to trapeze.
- K. Vertical Runs: Vertical runs of piping or ductwork shall be braced at each floor and roof level. Provide intermediate lateral braces at 13 foot maximum spacing where story height exceeds 13 feet.

- L. Spreaders: Required between racked or adjacent piping runs to prevent contact during seismic activity whenever pipe or insulated pipe surfaces are less than 4 inches (or four times the maximum displacement due to seismic force) apart. Spreaders shall be applied at same interval as sway braces. Spreaders shall be applied to surface of bare or insulated hot pipe, and over insulation utilizing high-density inserts and pipe protection shields where vapor-barrier-type insulation is employed.
- M. Flexible Couplings or Joints: Flexible couplings and joints of the mechanical joint type may be used for aboveground piping. Flexible couplings or joints in building piping shall be provided at bottom of all pipe risers larger than 3½ inches in diameter.
- N. Mechanical couplings for steel or cast-iron pipe shall be of the sleeve type and shall provide a tight flexible joint under all reasonable conditions, such as pipe movement caused by expansion, contraction, slight settling or shifting of the ground, minor variations in trench gradients, and traffic vibrations. Where permitted in other sections of these specifications, joints utilizing split-half couplings with grooved or shouldered pipe ends may be used.
- O. Sleeve-type couplings shall be used for joining plain-end pipe sections. The coupling shall consist of one steel middle ring, two steel followers, two gaskets, and necessary steel bolts and nuts to compress the gaskets. Underground bolts shall be galvanized.

3.04 ELECTRICAL EQUIPMENT

- A. Electrical Equipment Bases: Oversized washers and/or reinforcing stiffeners extending to the equipment wall are required at bolted connections through the base, for any equipment bases not designed to transfer seismic loads.
- B. Internal coils of dry type transformers shall be positively attached to their supporting structure within the transformer.
- C. Slide-out components in electrical control panels, computer equipment, etc. shall have a latching mechanism to hold contents in place.
- D. Cutouts in the lower shear panel of electrical cabinets are prohibited, unless one of the following exceptions is met:
 - 1. Factory cutouts made by the manufacturer.
 - 2. Cutouts supported by an analysis demonstrating that remaining cabinet strength is sufficient.
- E. Attachment of additional external items to electrical equipment is prohibited, unless one of the following exceptions is met:
 - 1. Items weighing less than 100 pounds.
 - 2. Items provided by the electrical equipment manufacturer.
 - 3. Items shown by analysis demonstrating their effects are supported by the design.

3.05 LIGHTING FIXTURES

- A. Lighting fixture supports shall be malleable iron unless specified to be of a higher quality (such as stainless-steel, etc.) in other sections of these specifications.
- B. A supporting assembly that is intended to be mounted on an outlet box shall be designed to accommodate mounting features on 4-inch boxes, 3-inch plaster rings, and fixture studs.
- C. Wall-mounted emergency light unit shall be secured in a manner to hold the unit in place during a seismic disturbance.
- D. Pendant Fixtures: Loop and hook or swivel hanger assemblies shall be fitted with a restraining device to hold the stem in the support position during earthquake motion. Pendant-supported fluorescent fixtures shall also be provided with a flexible hanger device at the attachment to the fixture channel to preclude breaking of the support. The motion of swivels or hinged joints shall not cause sharp bends in conductors or damage to insulation.

- E. Chain Hung Fixtures: Support from each corner directly to ceiling structure above. Secure chain to fixture and ceiling with bolted connections.
- F. Cable Hung Fixtures: Support by a pre-manufactured and pre-certified cable hanger system. A typical support shall include a ceiling connector (anchor, eyebolt, etc.), a stainless-steel 3/32" or thicker cable (length as required) and a fixture connector flange assembly. The fixture connector assembly shall be secured to the fixture housing with two screws. A typical 1' x 4' fixture shall require two supports, one at each end of the fixture.
- G. Recessed fluorescent individual or continuous-row fixtures: Support by a seismic-resistant suspended ceiling support system. Except where restricted below, the fixtures shall be bolted, screwed, or riveted to the ceiling system runners at each corner of the fixture. In addition, provide with fixture support wires attached to the building structural members using two wires for individual fixtures and one wire per unit of continuous row fixtures.
 - 1. All lighting fixtures over 56 pounds in weight shall be attached to building structural members utilizing fixture support wires.
 - 2. All recessed fixtures 4 s.f. or more in area in the horizontal plane shall also be secured with two wires as described in Division 26 Section "Interior Lighting."

3.06 CEILING-MOUNTED COMPONENTS

- A. Definition: For the purpose of this section, a ceiling-mounted component includes but is not limited to lighting fixtures. In addition, ceiling components also include speakers, grilles and diffusers, radiant heating panels, fire alarm devices, occupancy detectors and the like.
- B. All ceiling-mounted components weighing 10 pounds (4.5 kg) or less shall have a #12 hanger wire attached to the component and to the structure above. The wire need not be taut. At the housing, loop the wire through an eye on the component housing and wrap a minimum of four times around itself. Install with a minimum of slack so that the wires do not exert significant pressure on the component and no pressure on the ceiling that would cause ceiling distortion.
- C. For ceiling-mounted components weighing more than 10 pounds (4.5 kg) but less than or equal to 56 pounds (25.4 kg), two #12 hanger wires shall be wire attached to the component and to the structure above. The wires need not be taut. At the housing, loop the wire through eyes on the component housing, one at each diagonal corner (for rectangular components) and wrap a minimum of four times around itself. Install with a minimum of slack so that the wires do not exert significant pressure on the component and no pressure on the ceiling that would cause ceiling distortion.
- D. For ceiling-mounted components weighing more than 56 pounds (25.4 kg), the component and any attachments shall be supported directly from the structure.

3.07 ARCHITECTURAL COMPONENTS

- A. Seismic bracing of non-structural architectural components (e.g., exterior curtainwalls, interior partitions, storage racks, veneers, cabinets, signs, appendages, and ornamentations, etc.) shall be in accordance with the prescriptive requirements of Article 13.5 of ASCE/SEI 7-16.

3.08 SUSPENDED ACOUSTICAL CEILING ASSEMBLIES

- A. All suspended ceiling systems shall be designed to withstand required seismic loads as specified in Part I of this Section. When calculating the force F_p , the ceiling weight shall include its own weight, plus the weight of all lighting fixtures, air devices and other ceiling-mounted components unless supported entirely independently of the ceiling system. In no case shall the weight of the ceiling be taken as less than 4.0 psf.

3.09 SEISMIC RELATIVE DISPLACEMENT

- A. Do not attach seismic anchorage or bracing for any one component to two or more elements of a structure subject to differential movement, such as a wall and a floor or two different floors.

- B. Do not attach seismic anchorage or bracing for any one component to two or more separate structures or structural systems.
- C. Piping, conduit, ductwork, cable tray, etc. shall be designed to accommodate differential movement between components and structures when attached to structures that could displace relative to each other and where the components cross a seismic isolation interface. Examples include vertical pipe or conduit risers; or a pump anchored to a floor and rigidly connected to piping anchored to the roof structure above.
- D. Furnish and install sufficient flexible fittings to accommodate the relative displacement.

3.10 ADJUSTING

- A. Adjustment: Adjust supports and restraints to distribute loads equally on attachments. Adjust snubbers according to manufacturer's written recommendations. Adjust seismic restraints to permit free movement of equipment within normal mode of operation.
- B. Torque anchor bolts according to equipment manufacturer's written recommendations to resist seismic forces.

3.11 CLEANING

- A. After completing equipment installation, inspect seismic-control devices. Remove paint splatters and other spots, dirt, and debris.
- B. Paint Touch-Up: Immediately after installation of equipment, devices, and seismic protection system; clean field welds, bolted connections, and abraded areas of shop paint. Apply paint to exposed areas per requirements in Division 09 painting sections.
- C. Galvanizing Touch-Up: Immediately after installation of equipment, devices, and seismic protection system; clean field welds, bolted connections, and abraded areas of galvanizing.
- D. Apply galvanizing repair paint to comply with ASTM A780.

3.12 FIELD QUALITY CONTROL

- A. Review: The Owner will engage an independent special inspection agent to review seismic restraint submittals and to perform the following field quality control review:
 - 1. Examine all mechanical and electrical systems and equipment to confirm all seismic restraint systems are installed properly and in compliance with these specifications and the submittals.
 - 2. Examine all seismic restraints and seismic snubbers for minimum clearances.
 - 3. Examine all cable bracing systems for proper installation, angle of slope, and tension or slack.
- B. Report: The Owner's special inspection agent shall submit a certification report(s) to the Owner's Representative for seismic special inspections to verify the above review and to include the following:
 - 1. Certify that all seismic-restraint systems are installed properly and in compliance with these specifications and the submittals.
 - 2. Identify those areas that require corrective measures or certify that no corrective measures are necessary.
 - 3. Any changes to the originally submitted seismic restraint designs, such as those due to field coordination, shall be clearly defined and detailed in the report.

END OF SECTION

THISPAGELEFT INTENTIONALLY BLANK

SECTION 21 0100
BASIC FIRE PROTECTION REQUIREMENTS

PART 1 - GENERAL

1.01 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.

1.02 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.
 - 6. Buy American Act Provision

1.03 REFERENCED STANDARDS

- A. International Fire Code 2018 (IFC)
- B. National Fire Protection Association Standards
- C. ASHRAE Standard 90.1, Energy Efficiency Design of New Buildings Except Low-Rise Residential Buildings.

1.04 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. Photocopies 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 photocopies 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.

1.05 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 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

3.01 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

**SECTION 21 0500
COMMON WORK RESULTS FOR FIRE SUPPRESSION**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Escutcheons.
 - 3. Grout.
 - 4. Fire-suppression equipment and piping demolition.
 - 5. Equipment installation requirements common to equipment sections.
 - 6. Painting and finishing.
 - 7. Concrete bases.
 - 8. Supports and anchorages.

1.03 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.

1.04 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
 - 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.
3. 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.
 4. 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. Photocopies 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.

1.05 SUBMITTALS

- A. Product Data: For the following:

1. Mechanical sleeve seals.
 2. Escutcheons.
- B. Welding certificates.

1.06 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.

1.07 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.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.08 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

2.01 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.

2.02 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.

2.03 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. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- 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 for Joining CPVC Plastic Piping: ASTM F 493.

2.04 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.
 1. One-Piece, Stamped-Steel Type: With set screw and chrome-plated finish.

2.05 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

3.01 FIRE-SUPPRESSION DEMOLITION

- A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove fire-suppression systems, equipment, and components indicated to be removed.
 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. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.02 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 or split-casting, cast-brass type with polished chrome-plated finish.
 - g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge and set screw.
 - h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed hinge and set screw or spring clips.
 - j. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
 - k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw or spring clips.
 - l. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
 - 2. Existing Piping: Use the following:
 - a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
 - b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and spring clips.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.
 - f. Bare Piping in Unfinished Service Spaces: Split-casting, cast-brass type with polished chrome-plated finish.

- g. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed hinge and set screw or spring clips.
 - h. Bare Piping in Equipment Rooms: Split-casting, cast-brass type.
 - i. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.
 - j. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.
- M. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using 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.
- 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- N. 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.
- O. Verify final equipment locations for roughing-in.
- P. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.03 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.
- I. Plastic 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. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

3.04 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.

3.05 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.06 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.

3.07 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor fire-suppression materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.08 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

THISPAGELEFT INTENTIONALLY BLANK

SECTION 21 1313
WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Pipes, fittings, and specialties.
 - 2. Fire-protection valves.
 - 3. Fire-department connections.
 - 4. Sprinklers.
 - 5. Alarm devices.
 - 6. Manual control stations.
 - 7. Control panels.
 - 8. Pressure gauges.
- B. Related Sections:

1.03 DEFINITIONS

- A. High-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure higher than standard 175 psig, but not higher than 250 psig.
- B. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175 psig maximum.

1.04 SYSTEM DESCRIPTIONS

- A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. 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.
- B. Deluge Sprinkler System: Open sprinklers are attached to piping connected to water supply through deluge valve. Fire-detection system, in same area as sprinklers, opens valve. Water flows into piping system and discharges from attached sprinklers when valve opens.

1.05 PERFORMANCE REQUIREMENTS

- A. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
- B. High-Pressure Piping System Component: Listed for 250-psig minimum working pressure.
- C. 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. Sprinkler Occupancy Hazard Classifications:
 - a. Automobile Parking Areas: Ordinary Hazard, Group 1.
 - b. Building Service Areas: Ordinary Hazard, Group 1.
 - c. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
 - d. General Storage Areas: Ordinary Hazard, Group 1.
 - e. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
 - f. Office and Public Areas: Light Hazard.
 - g. Plastics Processing Areas: Extra Hazard, Group 2.
 - h. Printing Plants: Extra Hazard, Group 1.
 - i. Repair Garages: Ordinary Hazard, Group 2.
 - j. Residential Living Areas: Light Hazard.

- k. Restaurant Service Areas: Ordinary Hazard, Group 1.
- l. Solvent Cleaning Areas: Extra Hazard, Group 2.
- m. Upholstering Plants: Extra Hazard, Group 1.
- 3. 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.
 - c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. area.
 - d. Extra-Hazard, Group 1 Occupancy: 0.30 gpm over 2500-sq. ft. area.
 - e. Extra-Hazard, Group 2 Occupancy: 0.40 gpm over 2500-sq. ft. area.
 - f. Special Occupancy Hazard: As determined by authorities having jurisdiction.
- 4. Retain one of first two subparagraphs below.
- 5. Maximum Protection Area per Sprinkler: Per UL listing.
- 6. 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.
- 7. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated:
 - a. Light-Hazard Occupancies: 100 gpm for 30 minutes.
 - b. Ordinary-Hazard Occupancies: 250 gpm for 60 to 90 minutes.
 - c. Extra-Hazard Occupancies: 500 gpm for 90 to 120 minutes.
- D. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7.

1.06 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. LEED Submittal:
 - 1. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content and chemical components.
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: For power, signal, and control wiring.
- D. Delegated-Design Submittal: For sprinkler systems 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. Coordinate first paragraph below with qualification requirements in Division 01 Section "Quality Requirements" and as supplemented in "Quality Assurance" Article.
- E. Qualification Data: For qualified Installer and professional engineer.
- F. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
 - 1. Sprinklers shall be referred to on drawings, submittals, and other documentation by the sprinkler identification or Model number as specifically published in the appropriate agency listing or approval. Trade names or other abbreviated designations shall not be allowed.
- G. Welding certificates.
- H. Fire-hydrant flow test report.
- I. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."

- J. Field quality-control reports.
- K. Operation and Maintenance Data: For sprinkler specialties to include in emergency, operation, and maintenance manuals.

1.07 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer's responsibilities include designing, fabricating, and installing sprinkler 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 Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. All grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
 - 1. All castings used for couplings housings, fittings, or valve and specialty bodies shall be date stamped for quality assurance and traceability.
- D. 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.
- E. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
 - 1. NFPA 13, "Installation of Sprinkler Systems."
 - 2. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."

1.08 PROJECT CONDITIONS

- A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:
 - 1. Notify Construction Manager and Owner no fewer than two days in advance of proposed interruption of sprinkler service.
 - 2. Do not proceed with interruption of sprinkler service without Construction Manager's and Owner's written permission.

1.09 COORDINATION

- A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.10 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and 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 used on Project.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

2.02 STEEL PIPE AND FITTINGS

- A. Standard Weight, Black-Schedule 40 Steel Pipe: ASTM A 53/A 53M, Type E- electrically resistance welded, Grade B. Pipe ends may be factory or field formed to match joining method.

- B. Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.
- C. Uncoated, Steel Couplings: ASTM A 865, threaded.
- D. Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- E. Malleable- or Ductile-Iron Unions: UL 860.
- F. Cast-Iron Flanges: ASME 16.1, Class 125.
- G. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
- H. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.
- I. In lieu of threaded steel piping systems, the Victaulic FireLock IGS System with "Installation-Ready™" fittings and couplings. System rated for a working pressure to 365 psi (2517 kPa). Not for use with Type F Schedule 40 pipe. Victaulic V9 coupling sprinkler heads may be used in direct substitution where applicable.
- J. Grooved-Joint, Steel-Pipe Appurtenances:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Victaulic Company
 - b. Anvil International, Inc.
 - c. Shurjoint Piping Products.
 - d. Tyco Fire & Building Products LP.
 - 2. Pressure Rating: 175 psig minimum.
 - 3. Uncoated, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, Grade 65-45-12 ductile-iron casting; with dimensions matching steel pipe. In applicable sizes, fittings shall be short pattern, with flow equal to standard pattern fittings.
 - a. Installation-Ready™ fittings for Schedule 40 grooved end steel piping in fire protection applications sizes NPS 1-¼ thru 2½ (DN 32 thru DN 65). Fittings shall consist of a ductile iron housing with Installation-Ready™ ends, pre-lubricated Grade "E" EPDM Type 'A' gasket, and ASTM A449 electroplated steel bolts and nuts. UL listed for a working pressure of 300 psi (2065 kPa) and FM approved for working pressure 365 psi (2517kPa)
 - 4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber center leg gasket, with pipe stop to ensure proper groove engagement, alignment and pipe insertion depth, and ASTM A449 electroplated steel bolts and nuts.
 - a. Rigid Type: Housings cast with offsetting, angle-pattern, boldt pads to provide system rigidity and support and hanging in accordance with NFPA-13, fully installed at visual pad-to-pad offset contact. (Couplings that require exact gapping at specific torque ratings are not permitted.). Installation-Ready for complete installation without field disassembly. Basis of Design: Victaulic Style 108, 109, 009N, and 107N.
 - b. Flexible Type: For use in locations where vibration attenuation and stress relief are required. Basis of Design: Victaulic Installation Ready Style 75, 77, and 177N.
- K. Steel Pressure-Seal Fittings: UL 213, FM-approved, 175-psig pressure rating with steel housing, rubber O-rings, and pipe stop; for use with fitting manufacturers' pressure-seal tools.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Victaulic Company.

2.03 COPPER TUBE AND FITTINGS

- A. Soft Copper Tube: ASTM B 88, Type K, water tube, annealed temper; with plain ends.
 - 1. Copper fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.

2. Brazing Filler Metals: AWS A5.8, BCuP-3 or BCuP-4.
- B. Plain-End, Hard Copper Tube: ASTM B 88, Type K, water tube, drawn temper.
 1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
 2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match tubing system.
 3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body with ball-and-socket metal-to-metal seating surfaces, and solder-joint or threaded ends.
 4. Brazing Filler Metals: AWS A5.8, BCuP-3 or BCuP-4.
- C. Grooved-End, Hard Copper Tube: ASTM B 88, Type K, water tube, drawn temper; with factory- or field-formed, roll-grooved ends.
 1. Grooved-Joint Systems:
 - a. Manufacturers:
 - 1) Anvil International, Inc.
 - 2) Victaulic Co. of America.
 - b. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting. Fittings may have ends factory or field expanded to steel-pipe OD if required for copper tube systems using grooved-end-pipe couplings.
 - c. Grooved-End-Tube Couplings: UL 213, rigid pattern, unless otherwise indicated; gasketed fitting equivalent to AWWA C606 but made to match copper-tube 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. Use grooved-end-pipe couplings for tube and fitting that have expanded ends.

2.04 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free.
 1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
 2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- D. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
 1. Plastic, Pipe-Flange Gasket, and Bolts and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.
- E. Groove Joint Lubricants: Lubricant gasket in accordance with the manufacturer's published instructions with lubricant approved for the gasket elastomer and fluid media.

2.05 COVER SYSTEM FOR SPRINKLER PIPING

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. DecoShield Systems, Inc.
- B. Description: System of support brackets and covers made to protect sprinkler piping.
- C. Brackets: Glass-reinforced nylon.
- D. Covers: Extruded PVC sections of length, shape, and size required for size and routing of CPVC piping.

2.06 TRIM AND DRAIN VALVES

- A. General Requirements:
 - 1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
 - 2. Pressure Rating: 175 psig minimum.
- B. Angle Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fire Protection Products, Inc.
 - b. United Brass Works, Inc.
- C. Ball Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Victaulic Company.
 - b. Anvil International, Inc.
 - c. NIBCO INC.
 - d. Tyco Fire & Building Products LP.
 - e. Watts Water Technologies, Inc.
- D. Globe Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fire Protection Products, Inc.
 - b. United Brass Works, Inc.

2.07 SPRINKLERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Reliable Automatic Sprinkler Co., Inc.
 - 2. Tyco Fire & Building Products LP.
 - 3. Victaulic Company.
 - 4. Viking Corporation.
- B. General Requirements:
 - 1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
 - 2. Pressure Rating for Residential Sprinklers: 175 psig maximum.
 - 3. Pressure Rating for Automatic Sprinklers: 175 psig minimum.
 - 4. Pressure Rating for High-Pressure Automatic Sprinklers: 250 psig minimum.
- C. Automatic Sprinklers with Heat-Responsive Element:
 - 1. Early-Suppression, Fast-Response Applications: UL 1767.
 - 2. Nonresidential Applications: UL 199.
 - 3. Residential Applications: UL 1626.
 - 4. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
- D. Open Sprinklers with Heat-Responsive Element Removed: UL 199.
 - 1. Characteristics:
 - a. Nominal 1/2-inch Orifice: With Discharge Coefficient K between 5.3 and 5.8.
 - b. Nominal 17/32-inch Orifice: With Discharge Coefficient K between 7.4 and 8.2.
- E. Sprinkler Finishes:
 - 1. Chrome plated.
 - 2. Bronze.

3. Painted.
- F. Special Coatings:
 1. Wax.
 2. Lead.
 3. Corrosion-resistant coating. Body shall be coated with a UL and FM approved anti-corrosion coating. Basis-of-Design Product: Subject to compliance with requirements, provide Victaulic VC-250 coating or equal.
- 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: Chrome-plated steel, one piece, flat or Chrome-plated steel, two piece, with 1-inch vertical adjustment.
 2. Sidewall Mounting: Chrome-plated steel one piece, flat.
- H. Sprinkler Guards:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Reliable Automatic Sprinkler Co., Inc.
 - b. Tyco Fire & Building Products LP.
 - c. Victaulic Company.
 - d. Viking Corporation.
 - e. Standard: UL 199.
 2. Type: Wire cage with fastening device for attaching to sprinkler.
 3. Escutcheons and guards shall be listed, supplied, and approved for use with the sprinkler by the sprinkler manufacturer.
 4. Wrenches shall be provided by the sprinkler manufacturer that directly engage the wrench boss cast in the sprinkler body.

2.08 MANUAL CONTROL STATIONS

- A. Description: UL listed, or FM approved, hydraulic operation, with union, NPS 1/2 pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

2.09 CONTROL PANELS

- A. Description: Single-area, two-area, or single-area cross-zoned control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves. Panels contain power supply; battery charger; standby batteries; field-wiring terminal strip; electrically supervised solenoid valves and polarized fire-alarm bell; lamp test facility; single-pole, double-throw auxiliary alarm contacts; and rectifier.
 1. Panels: UL listed, and FM approved when used with thermal detectors and Class A detector circuit wiring. Electrical characteristics are 120-V ac, 60 Hz, with 24-V dc rechargeable batteries.
 2. Manual Control Stations: Electric operation, metal enclosure, labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.
 3. Manual Control Stations: Hydraulic operation, with union, NPS 1/2 pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.

- B. Report test results promptly and in writing.

3.02 SERVICE-ENTRANCE PIPING

- A. Connect sprinkler piping to water-service piping for service entrance to building. Comply with requirements for exterior piping in Division 21 Section "Facility Fire-Suppression Water-Service Piping."
- B. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

3.03 WATER-SUPPLY CONNECTIONS

- A. Connect sprinkler piping to building's interior water-distribution piping. Comply with requirements for interior piping in Division 22 Section "Domestic Water Piping."
- B. Install shutoff valve, check valve, pressure gage, and drain at connection to water supply.

3.04 PIPING INSTALLATION

- A. 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.
- B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.
- C. Install seismic restraints on piping. Comply with requirements for seismic-restraint device materials and installation in NFPA 13.
- D. Install a single air vent with a manual, automatic, or other approved connection near a high point of the system on each wet pipe system utilizing metallic pipe for air removal.
- E. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- F. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- G. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- H. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- I. Install sprinkler piping with drains for complete system drainage.
- J. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- K. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.
- L. Install alarm devices in piping systems.
- M. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
- N. 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.
- O. Fill sprinkler system piping with water.
- P. Install electric heating cables and pipe insulation on sprinkler piping in areas subject to freezing. Comply with requirements for heating cables in Division 21 "Heat Tracing for Fire- Suppression Piping" and for piping insulation in Division 21 Section "Fire-Suppression Systems Insulation."

- Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 21 Section "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 21 Section "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 21 Section "Escutcheons for Fire-Suppression Piping."

3.05 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
 - 1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
- I. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606 in accordance with the manufacturer's latest published instructions. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints. Grooved coupling manufacturer's factory trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools, application of groove, and installation of grooved piping products. The factory trained representative shall periodically visit the jobsite to ensure best practices in grooved product installation are being followed. Contractor shall remove and replace any improperly installed products.
- J. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606 in accordance with the manufacturer's latest published instructions. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints. Grooved coupling manufacturer's factory trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools, application of groove, and installation of grooved piping products. The factory trained representative shall periodically visit the jobsite to ensure best practices in grooved product installation are being followed. Contractor shall remove and replace any improperly installed products.

- K. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.
- L. Plastic-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. Apply primer.
 - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

3.06 INSTALLATION OF COVER SYSTEM FOR SPRINKLER PIPING

- A. Install cover system, brackets, and cover components for sprinkler piping according to manufacturer's "Installation Manual" and with NFPA 13 for supports.

3.07 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 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. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
 - 2. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.
 - 3. Deluge Valves: Install in vertical position, in proper direction of flow, and in main supply to deluge system. Install trim sets for drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

3.08 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels.
- B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.
- C. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.
- D. Do not install sprinklers that have been dropped, damaged, show a visible loss of fluid, or a cracked bulb.
- E. The sprinkler bulb protector shall be removable by hand, without tools or devices that may damage the bulb.

3.09 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge systems 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. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 4. Energize circuits to electrical equipment and devices.
 5. Start and run excess-pressure pumps.
 6. Coordinate with fire-alarm tests. Operate as required.
 7. Coordinate with fire-pump tests. Operate as required.
 8. Verify that equipment hose threads are same as local fire-department equipment.
- C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.11 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.

3.12 PIPING SCHEDULE

- A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends; cast-iron threaded fittings; and threaded, grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
- B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
- C. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be one of the following:
 1. Standard-weight Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 2. Standard-weight Schedule 40, black-steel pipe with cut or roll grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 3. Standard-weight Schedule 40, black-steel pipe with plain ends; steel welding fittings; and welded joints.
 4. Plain-end, Type K, hard copper tube; wrought-copper fittings; and brazed joints.
- D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 4, shall be one of the following:
 1. Standard-weight Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 2. Standard-weight Schedule 40, black-steel pipe with cut or roll grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 3. Standard-weight Schedule 40, black-steel pipe with plain ends; steel welding fittings; and welded joints.
 4. Plain-end, Type K, hard copper tube; wrought-copper fittings; and brazed joints.

3.13 SPRINKLER SCHEDULE

- A. Use sprinkler types in subparagraphs below for the following applications:
 1. Rooms without Ceilings: Upright sprinklers.
 2. Rooms with Suspended Ceilings: Concealed sprinklers.
- B. Provide sprinkler types in subparagraphs below with finishes indicated.
 1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
 2. Flush Sprinklers: Bright chrome, with painted white escutcheon.
 3. Upright Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION

THISPAGELEFT INTENTIONALLY BLANK

SECTION 22 0100
BASIC PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.01 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.

1.02 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.
 - 6. Buy American Act Provision

1.03 REFERENCED STANDARDS

- A. International Plumbing Code 2018 (IPC)
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers. Guideline 4-2008 *Preparation of Operating and Maintenance Documentation for Building Systems*. Atlanta, GA: ASHRAE, 2008.
- C. ASHRAE Standard 90.1, Energy Efficiency Design of New Buildings Except Low-Rise Residential Buildings.

1.04 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. Photocopies 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 photocopies 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 Introba 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 Introba.

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 Introba 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 Introba as to the accuracy or correctness of the information provided. Introba accepts no responsibility or liability for the use of the provided information.

1.05 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

2.01 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.

PART 3 – EXECUTION – (NOT APPLICABLE)

END OF SECTION

THISPAGELEFT INTENTIONALLY BLANK

SECTION 22 0500
BASIC PLUMBING MATERIALS AND METHODS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 20 0800 "Seismic Protection" and Section 22 0100 "Basic Plumbing Requirements" [apply / applies] to the work of this Section as if fully repeated herein.

1.02 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. Flexible pipe connectors.
 - 5. Plumbing sleeve seals.
 - 6. Pipe sleeves.
 - 7. Escutcheons.
 - 8. Penetration firestopping of fire-resistance-rated assemblies and/or smoke barriers by plumbing piping or conduit.
 - 9. Labeling and identifying plumbing systems and equipment.
 - 10. Non-shrink grout for equipment installations.
 - 11. Painting and finishing of plumbing work.
 - 12. Concrete base construction requirements.
 - 13. Coordination with Structural work.
 - 14. Field-fabricated equipment supports.
 - 15. Selective Demolition.
 - 16. Cutting and patching.
- B. Pipe and pipe fitting materials are specified in individual Division 22 piping system Sections.

1.03 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.

1.04 SUBMITTALS

- A. Product Data: For dielectric fittings, transition couplings, flexible pipe connectors, plumbing sleeve seals, escutcheons, 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.
- E. Samples: Of color, lettering style, and other graphic representation required for each identification material and device.

1.05 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.

1.06 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.

1.07 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

2.01 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. Eclipse, Inc.; Rockford-Eclipse Div.
 - b. Grinnell Corp.; Grinnell Supply Sales Co.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Zurn Industries, Inc.; Wilkins Div.
 - 3. Flexible Pipe Connectors:
 - a. Flexicraft Industries, Inc.
 - b. Hyspan Precision Products, Inc.
 - c. Mason Industries, Inc.
 - d. The Metraflex Company
 - e. Proco Products, Inc.
 - 4. Plumbing Sleeve Seals:
 - a. Advanced Products and Systems, Inc./Innerlynx
 - b. The Metraflex Company
 - c. Thunderline/Link-Seal.
 - 5. 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.

2.02 PIPE AND PIPE FITTINGS

- A. Refer to individual Division 22 piping Sections for pipe and fitting materials and joining methods.

2.03 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. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
 1. Bolts and nuts shall be Type 304 stainless-steel if installed on uninsulated piping located outdoors.
 2. Bolts and nuts shall be Type 316 stainless-steel if installed on uninsulated direct-bury piping.
- F. Solder Filler Metals: ASTM B32 lead-free alloys. Include water-flushable flux according to ASTM B813.
- G. 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.
- H. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- I. Solvent Cements: Manufacturer's standard solvent cements for the following:
 1. ABS Piping: ASTM D2235.
- J. Plastic Pipe Seals: ASTM F477, elastomeric gasket.
- K. 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.
 2. Bolts and nuts shall be Type 316 stainless-steel if installed on uninsulated direct-bury piping.

2.04 DIELECTRIC FITTINGS

- A. General: Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.
- B. Description: Combination of copper alloy and ferrous, threaded, solder, plain, and weld-neck end types and matching piping system materials.
- C. Insulating Material: Suitable for system fluid, pressure, and temperature.
- D. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180°F (82 C).
- E. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
- F. Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, 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.
- G. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225°F (107 C).
- H. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225°F (107°C).

2.05 FLEXIBLE PIPE CONNECTORS

- A. General: Fabricated from materials suitable for system fluid and that will provide equipment-pipe connections.
- B. Flexible Pipe Connectors for Copper Piping: Corrugated bronze inner tubing covered with interwoven bronze wire braid. Include copper-tube ends, brazed to hose.

- C. Flexible Pipe Connectors for Steel Piping: Corrugated stainless-steel inner tubing covered with interwoven stainless-steel wire braid.
- D. Performance Rating Requirements:
 - 1. Misalignment: Rated for ¾-inch (20-mm) permanent lateral offset.
 - 2. Length: As needed to allow offset rating above, but not less than 9-inches (230 mm).
 - 3. Design Working Pressure: 150 psig (1035 kPa) at 300°F (149°C).
- E. Schedule of End Connections:
 - 1. 2-Inch NPS (DN50) and Smaller, Copper Pipe: Copper tube end connections suitable for soldering to adjacent piping; except that brazed end connections are required for refrigerant service.
 - 2. 2-Inch NPS (DN50) and Smaller, Steel Pipe: Threaded-end carbon steel nipples welded to hose; except that stainless-steel ends are required for natural gas service or where mated to stainless-steel piping.
 - 3. 2½-Inch NPS (DN65) and Larger: Carbon-steel flanged end connections welded to hose and drilled to meet ANSI Class 150; except that stainless-steel flanged end connections are required for natural gas service or where mated to stainless-steel piping.
- F. Flexible pipe connectors specified herein are for use at the piping connection to a piece of plumbing 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 22 Section “Pipe Expansion Fittings” for pipe expansion joints or pipe expansion fittings.

2.06 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: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
- C. Pressure Plates: Stainless-steel. Include two for each sealing element.
- D. Connecting Bolts and Nuts: 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).

2.07 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.
- F. 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.

2.08 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.

2.09 PIPING SYSTEMS

- A. Penetration firestopping systems shall bear classification marking of UL or FM.
- B. Penetrations in Fire-Resistance-Rated Assemblies: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).
 1. F-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated.
 2. T-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
 3. W-Rating: Provide penetration firestopping systems showing no evidence of water leakage when tested according to UL 1479.
- C. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined per UL 1479, based on testing at a positive pressure differential of 0.30-inch wg (74.7 Pa).
 1. L-Rating: Not exceeding 5.0 cfm/sq. ft. (0.025 cu. m/s per sq. m) of penetration opening at and no more than 50-cfm (0.024-cu. m/s) cumulative total for any 100 sq. ft. (9.3 sq. m) at both ambient and elevated temperatures.
- D. Accessories: Provide components such as permanent forming/damming/backing materials, substrate primers, collars, and/or steel sleeves for each penetration firestopping system as necessary to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.
- E. Mixing: For those products requiring mixing before application, comply with penetration firestopping system 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.

2.10 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 ¼-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."

2.11 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-psi (34.5-MPa), 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

2.12 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."
 - A. 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.
 - B. Colors: As directed by Owner's representative. Each pipe shall be painted a designated color according to service.

PART 3 - EXECUTION

3.01 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.

3.02 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. Aboveground, Exterior-Wall, Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeve for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical 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 mechanical sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber-sealing elements to expand and make watertight seal.
- J. Underground, Exterior-Wall, Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Size sleeve for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals. Assemble and install mechanical sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber-sealing elements to expand and make watertight seal.
- K. Sleeves are not required for core-drilled holes.
- L. Permanent sleeves are not required for holes formed by PE removable sleeves.
- M. 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.

3.03 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."

3.04 PENETRATION FIRESTOPPING INSTALLATION

- A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."
- B. Environmental Limitations: Do not install penetration firestopping system when ambient or substrate temperatures are outside limits permitted by penetration firestopping system manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.
- C. Coordinate construction of openings and penetrating items to ensure that penetration firestopping systems can be installed according to specified firestopping system design.
- D. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping systems.
- E. 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. Proceed with installation only after unsatisfactory conditions have been corrected.
- F. Surface Cleaning: Before installing penetration firestopping systems, clean out openings immediately 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 materials.
 - 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping materials. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.
- G. 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.
- H. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications. Install and cure

penetration firestopping materials per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

- I. 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. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.
- J. Install fill materials by proven techniques to produce the following results:
 - 1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items to achieve required fire-resistance ratings.
 - 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.
- K. 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 system manufacturers and that do not damage materials in which openings occur.
- L. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping systems are 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 material and install new materials to produce systems complying with specified requirements.

3.05 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.

3.06 PAINTING AND FINISHING

- A. For all painting and finishing work required for plumbing installations, refer to Division 09 Sections for application requirements.
- B. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45°F. Maintain containers in clean condition, free of foreign materials and residue. Remove rags and waste from storage areas daily.
- C. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50°F and 95°F. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5°F above the dew point; or to damp or wet surfaces.
- D. Examine substrates and conditions for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- 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. Application of coating indicates acceptance of surfaces and conditions.
- G. Comply with manufacturer's written instructions and recommendations in "Master Painters Institute (MPI) Manual" applicable to substrates indicated.
- H. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints. Remove surface oxidation, loose mill scale, and shop primer, if any. Clean field welds, bolted connections, and abraded areas of shop paint.
- I. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual." Use applicators and techniques suited for paint and substrate indicated. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
- J. 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.
- K. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- L. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- M. 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.
- N. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.
- O. 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.

- P. In addition, paint the following:
 - 1. Equipment, and pipe insulation having ASJ or other paintable jacket material.
- Q. Steel Substrates: Primer, alkyd, anti-corrosive, for metal, MPI #79; plus topcoat of latex, interior, semi-gloss, MPI #54.
- R. Galvanized-Metal Substrates: Primer, galvanized, water based, MPI #134; plus topcoat of latex, interior, semi-gloss, MPI #54.
- S. Aluminum (Not Anodized or Otherwise Coated) Substrates: Primer, quick dry, for aluminum, MPI #95; plus topcoat of latex, interior, semi-gloss, MPI #54.
- T. ASJ Insulation-Covering Substrates: Including pipe and duct coverings. Primer sealer, latex, interior, MPI #50; plus topcoat of latex, interior, semi-gloss, MPI #54.
- U. Primers specified above may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

3.07 CONCRETE BASES

- A. Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to Division 20 Section "Seismic Protection."
- 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 to elevations required for proper attachment to supported equipment.
- G. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
- H. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 03.

3.08 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.

3.09 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."

3.10 SELECTIVE DEMOLITION

- A. Disconnect, demolish, and remove plumbing 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. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
- C. Removal: Unless otherwise indicated, remove demolished pipe, 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.

3.11 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 plumbing 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 plumbing equipment, components, and materials as indicated, including but not limited to removal of plumbing piping, pumps, and other plumbing items made obsolete by the new Work.
- E. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for plumbing 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 plumbing installation, so as to maintain an equivalent insulation or fire rating as existed without said plumbing installation.
- J. Refer to Division 01 Sections "Execution" and/or "Cutting and Patching" for additional requirements.

3.12 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

THISPAGELEFT INTENTIONALLY BLANK

SECTION 22 0523

VALVES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- 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.

1.02 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.
 - 4. Chainwheel actuators.
- B. Related Sections include the following:
 - 1. Division 22 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 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.

1.03 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.

1.04 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.

1.05 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. NSF Compliance: NSF 61 for valve materials for potable-water service in compliance with Public Law #111-380.
- D. MSS Compliance: Comply with the various MSS Standard Practice documents referenced herein.
- E. Buy-American: All valves shall be furnished from domestic sources (USA).

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, 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.
- 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.
- D. If this is NOT a government project that requires the contractor to meet "Buy American Act", removed Section 1.6 below.

PART 2 - PRODUCTS

2.01 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. 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.
 - 2. Conbraco Industries, Inc.; Apollo Div.
 - 3. Jamesbury, Inc.
 - 4. Watts
 - 5. Nibco
- 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. Central Sprinkler Co.; Central Grooved Piping Products
 - 3. Crane Co.; Crane Valve Group; Center Line brand.
 - 4. General Signal; DeZurik Unit
 - 5. McWane, Inc.; Kennedy Div.
 - 6. Victaulic Co. of America.

- 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: Any of the manufacturers listed under the "General" subheading above.
1. Nibco
 2. Watts
 3. Kennedy
 4. Apollo

2.02 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. 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.
- J. 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.

2.03 BALL VALVES

- A. See section 226700 for "Processed Water Systems for Laboratory and Healthcare Facilities".
- B. 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.
- C. Compressed Air Service, Size NPS 2 (DN 50) and smaller:
1. Minimum CWP rating: 600-psig (4140-kPa).
 2. Body: ASTM B584 bronze, two-piece construction, vented.
 3. Ball: Chrome-plated bronze alloy, full port.

4. Stem: Blowout-proof bronze alloy.
5. Packing: PTFE or TFE.
6. Ends: Threaded.
7. Handle: Vinyl-covered steel lever with stainless-steel locking mechanism; and zinc-plated steel nut.

2.04 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.
 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.

2.05 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.
- 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.
- D. Lift-Disc Check Valves for Compressed Air Service: Valve shall conform to FCI 74-1.
 1. Minimum pressure rating: Class 125.
 2. Body: Bronze or bronze-alloy.

3. Disc and seat: Renewable; bronze-alloy, spring-loaded; piston style.
4. Spring and set-screws: Stainless-steel.
5. Ends: Threaded.

PART 3 - EXECUTION

3.01 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.

3.02 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 chainwheel operators where specified. Extend chains to within 60 inches (1520 mm) above finished floor elevation.
- H. 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.
 2. Dual-Plate Wafer Check Valves: In horizontal position, or vertical with upward flow.
 3. Lift Check Valves: With stem upright and plumb.

3.03 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.

3.04 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.

3.05 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 throttling duty, NPS 2 (DN 50) and smaller, use ball valves.
 4. For throttling duty, NPS 2½ (DN 65) and larger, use butterfly 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.
- C. Compressed-Air Piping: Use vented ball valves for shutoff and throttling duty; use lift-disc check valves for one-way flow control.

END OF SECTION

**SECTION 22 0529
HANGERS AND SUPPORTS**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- 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.

1.02 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.

1.03 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."

1.04 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. 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.

1.05 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. Equipment supports.
 5. 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.

1.06 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

2.01 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.

2.02 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.
- D. Copper Pipe Hangers:
 1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless-steel unless noted otherwise.

2.03 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.

2.04 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.

2.05 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.

2.06 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.07 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

3.01 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. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications, including the following:
 - 1. All piping installed outdoors.
- F. Use padded hangers for piping that is subject to scratching.
- G. 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.
- H. 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.
- I. 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).
- J. 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).
- K. 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.
- L. 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.
- M. 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.
- N. 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).
- O. 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.

3.02 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 Compressed Air piping systems:
 1. NPS ½ (DN 15): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8-inch (10 mm).
 2. NPS ¾ (DN 20): Maximum span, 9 feet (2.7 m); minimum rod size, 3/8-inch (10 mm).
 3. NPS 1 (DN 25): Maximum span, 9 feet (2.7 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, 12 feet (3.7 m); minimum rod size, 3/8-inch (10 mm).
 6. NPS 2 (DN 50): Maximum span, 13 feet (4 m); minimum rod size, 3/8-inch (10 mm).
 7. NPS 2½ (DN 65): Maximum span, 14 feet (4.3 m); minimum rod size, 1/2-inch (13 mm).
 8. NPS 3 (DN 80): Maximum span, 15 feet (4.6 m); minimum rod size, 1/2-inch (13 mm).
 9. NPS 4 (DN 100): Maximum span, 17 feet (5.2 m); minimum rod size, 5/8-inch (16 mm).
 10. NPS 5 (DN 125): Maximum span, 20 feet (6.1 m); minimum rod size, 3/4-inch (19 mm).
 11. NPS 6 (DN 150): Maximum span, 20 feet (6.1 m); minimum rod size, 3/4-inch (19 mm).
 12. NPS 8 (DN 200): Maximum span, 20 feet (6.1 m); minimum rod size, 7/8-inch (22 mm).
 13. NPS 10 (DN 250): Maximum span, 20 feet (6.1 m); minimum rod size, 7/8-inch (22 mm).
 14. NPS 12 (DN 300): Maximum span, 20 feet (6.1 m); minimum rod size, 7/8-inch (22 mm).
 15. NPS 14 (DN 350): Maximum span, 20 feet (6.1 m); minimum rod size, 1-inch (25 mm).
 16. NPS 16 (DN 400): Maximum span, 20 feet (6.1 m); minimum rod size, 1-inch (25 mm).
 17. NPS 18 (DN 450): Maximum span, 20 feet (6.1 m); minimum rod size, 1¼-inches (32 mm).
 18. NPS 20 (DN 500): Maximum span, 20 feet (6.1 m); minimum rod size, 1¼-inches (32 mm).
 19. NPS 24 (DN 600): Maximum span, 20 feet (6.1 m); minimum rod size, 1¼-inches (32 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. Drawn-Temper Copper Piping for Compressed Air and/or Medical Gas piping systems:
1. NPS ½ (DN 15): Maximum span, 6 feet (1.8 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, 10 feet (3 m); minimum rod size, 3/8-inch (10 mm).
 6. NPS 2 (DN 50): Maximum span, 11 feet (3.4 m); minimum rod size, 3/8-inch (10 mm).
 7. NPS 2½ (DN 65): Maximum span, 13 feet (4 m); minimum rod size, 1/2-inch (13 mm).
 8. NPS 3 (DN 80): Maximum span, 14 feet (4.3 m); minimum rod size, 1/2-inch (13 mm).
 9. NPS 4 (DN 100): Maximum span, 16 feet (4.9 m); minimum rod size, 5/8-inch (16 mm).
- E. Drawn-Temper Copper Piping for Fuel Gas piping systems:
1. NPS ½ (DN 15): Maximum span, 6 feet (1.8 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, 10 feet (3 m); minimum rod size, 3/8-inch (10 mm).
 6. NPS 2 (DN 50): Maximum span, 10 feet (3 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).
- F. 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).
- G. 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.

- H. Support vertical runs at roof, at each floor, and at 10-foot (3-m) intervals between floors.
- I. Rod diameters may be reduced one size for double-rod hangers, with 3/8-inch (10 mm) minimum rods.
- J. Hanger and support spacing for piping and tubing not listed above shall be according to MSS SP-69 and piping manufacturer's written instructions.

3.03 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. 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: Install in pipe hanger or shield for insulated piping.
- 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.
- N. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

3.04 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.

3.05 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and/or equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.06 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).

3.07 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

THISPAGELEFT INTENTIONALLY BLANK

SECTION 22 0700
PLUMBING PIPE INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- 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.

1.02 SUMMARY

- A. This Section includes plumbing insulation for, equipment, piping, and other installations, including the following:
 - 1. Insulation Materials:
 - a. Calcium silicate.
 - b. Cellular glass.
 - c. Flexible elastomeric.
 - d. Mineral fiber.
 - 2. Fire-rated insulation systems.
 - 3. Insulating cements.
 - 4. Adhesives.
 - 5. Mastics.
 - 6. Sealants.
 - 7. Factory-applied jackets.
 - 8. Field-applied fabric-reinforcing mesh.
 - 9. Field-applied cloths.
 - 10. Field-applied jackets.
 - 11. Tapes.
 - 12. Securements.
 - 13. Protective shielding guards.
- B. Related Sections include the following:

1.03 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.

1.04 SUBMITTALS

- A. Product Data: For each type of product indicated, identify thermal conductivity, thickness, and jackets (both factory and field applied, if any).
- B. Sustainable Design Submittals.
 - 1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.

2. Laboratory Test Reports for credit IEQ 4: For solvent cements and adhesive primers documentation indicating that products comply with the testing and product requirements for the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers".
- 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, 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.
- E. Installer Certificates: Signed by Contractor certifying that installers comply with requirements.
- F. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- G. Field quality-control inspection reports.

1.05 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.

1.06 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.

1.07 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.

1.08 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

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
1. Calcium Silicate Insulation:
 - a. Industrial Insulation Group (The); Thermo-12 Gold.
 2. Cellular Glass Insulation:
 - a. Pittsburgh Corning Corporation; Foamglas Super K.
 3. 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.
 4. Mineral-Fiber, Preformed Pipe Insulation:
 - a. Johns Manville.
 - b. Knauf Insulation.
 - c. Manson Insulation Inc.
 - d. Owens Corning.
 5. 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.
 6. 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.
 7. 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.
 8. 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.
- 9. 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.
- 10. Insulation Pins and Hangers: Same as insulation manufacturer, or
 - a. AGM Industries, Inc.
 - b. GEMCO.
 - c. Midwest Fasteners, Inc.
 - d. Nelson Stud Welding.

2.02 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. Calcium Silicate:
 - 1. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C533, Type I.
 - 2. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C533, Type I.
 - 3. Prefabricated Fitting Covers: Comply with ASTM C450 and ASTM C585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.
 - 4. Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800°F (10 to 427 C).
- H. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Comply with ASTM C552, Type II, Class 2.
 - 1. Thermal Conductivity: 0.26 average maximum at 75°F mean temperature.
 - 2. Jacket: White, 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.
 - 3. Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300°F (minus 59 to plus 149 C).
- I. 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.
- J. 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, 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.
 3. Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 4. Low emitting (VOC) adhesive.
- K. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid 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: 0.27 average maximum at 100°F mean temperature.
 2. Density: 2.5 pcf (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: Comply with MIL-A-3316C, Class 2, Grade A.
 5. Low emitting (VOC) adhesive.

2.03 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C195.
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.
- C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449/C 449M.
- D. Low emitting (VOC) Cement.

2.04 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
 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. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below-ambient services.
 1. Water-Vapor Permeance: ASTM E96, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
 2. Service Temperature Range: Minus 20 to plus 180°F (Minus 29 to plus 82 C).
 3. Solids Content: ASTM D1644, 59 percent by volume and 71 percent by weight.
 4. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
 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: Minus 20 to plus 200°F (Minus 29 to plus 93 C).
 3. Solids Content: 63 percent by volume and 73 percent by weight.
 4. Color: White.

2.05 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.
- C. FSK and Metal Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Fire- and water-resistant, flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 40 to plus 250°F (Minus 40 to plus 121 C).
 4. Color: Aluminum.
- D. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Fire- and water-resistant, flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 40 to plus 250°F (Minus 40 to plus 121 C).
 4. Color: White.

2.06 FIELD-APPLIED CLOTHS AND FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. (68 g/sq. m) with a thread count of 10 strands by 10 strands/sq.-inch (4 strands by 4 strands/sq. mm) for covering pipe and pipe fittings.
- B. Woven Glass-Fiber Fabric for Equipment Insulation: Approximately 6 oz./sq. yd. (203 g/sq. m) with a thread count of 5 strands by 5 strands/sq.-inch (2 strands by 2 strands/sq. mm) for covering equipment.
- C. Woven Polyester Fabric: Approximately 1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq.-inch (4 strands by 4 strands/sq. mm), in a Leno weave, for duct, equipment, and pipe.
- D. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd. (271 g/sq. m).

2.07 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.
- C. Metal Jackets: Sheet and roll stock ready for shop or field sizing. Factory pre-cut and rolled to size is also acceptable. Material, finish, and thickness are indicated in field-applied jacket schedules.
1. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
 2. Stainless-Steel Jacket: ASTM A167 or ASTM A240.
 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.

2.08 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: 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.
- 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.

2.09 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 ¼-inch- (19-mm-) wide, stainless-steel or Monel.
- D. Wire: 0.062-inch (1.6-mm) soft-annealed, stainless-steel.

2.10 PROTECTIVE SHIELDING GUARDS

- A. Protective Shielding Pipe Covers.
1. Description: Manufactured plastic wraps for covering plumbing fixture hot-water supply 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

3.01 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.

3.02 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.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.03 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.

3.04 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 Below-Grade Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. 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.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- 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. Firestopping and fire-resistive joint sealers are specified in Division 07 Section "Penetration Firestopping."
- F. 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."

3.05 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 Calcium Silicate Insulation Installation:
1. Secure single-layer insulation with stainless-steel bands at 12-inch (300-mm) intervals and tighten bands without deforming insulation material.
 2. Install 2-layer insulation with joints tightly butted and staggered at least 3-inches (75 mm). Secure inner layer with wire spaced at 12-inch (300-mm) intervals. Secure outer layer with stainless-steel bands at 12-inch (300-mm) intervals.
 3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1-inch (25 mm). Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.
 4. Finish flange insulation, fittings insulation, valve and specialty insulation same as pipe insulation.
- 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.
- J. Special Requirements for Polyisocyanurate Insulation Installation:
1. Apply three separate wraps of filament tape on each insulation segment, to secure pipe insulation to pipe prior to installation of PVDC jacket.
 2. Wrap factory-presizes jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2-inches (50 mm) over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1¼ circumferences of appropriate PVDC tape around overlapped butt joint.
 3. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.

4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33½-inches (850 mm) or less. The 33½-inch- (850-mm-) circumference limit allows for 2-inch- (50-mm-) overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for “fishmouthing,” and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1¼ circumferences to avoid damage to tape edges.

3.06 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.
- C. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
 1. Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.
 2. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of lagging adhesive.
 3. Completely encapsulate insulation with coating, leaving no exposed insulation.

3.07 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.”

3.08 FINISHES

- A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- B. 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.

3.09 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent inspecting agency to perform field inspections and prepare inspection reports.
- B. Perform the following field tests and inspections and prepare test reports:
 1. Inspect ductwork in two locations randomly selected by Owner's Representative, by removing field-applied jacket and insulation in layers in reverse order of their installation.

2. Inspect two pieces of field-insulated equipment, randomly selected by Owner's Representative, by removing field-applied jacket and insulation in layers in reverse order of their installation. For large equipment, remove only a portion adequate to determine compliance.
 3. Inspect pipe, fittings, strainers, and valves, randomly selected by Owner's Representative, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements. Remove defective Work.
- D. Install new insulation and jackets to replace insulation and jackets removed for inspection. Repeat inspection procedures after new materials are installed.

3.10 EQUIPMENT INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
- B. Insulate indoor and outdoor equipment in below that is not factory insulated.
- C. Heat-exchanger (for domestic hot water service) insulation shall be any of the following:
1. Calcium Silicate: 3-inches (75 mm) thick.
 2. Cellular Glass: 3-inches (75 mm) thick.
 3. Mineral-Fiber Pipe and Tank: 2-inches (50 mm) thick.
- D. Thermal storage tank insulation shall be any of the following:
1. Cellular Glass: 4-inches (100 mm) thick.
 2. Mineral-Fiber Pipe and Tank: 3-inches (75 mm) thick.

3.11 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.

3.12 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. Mineral-Fiber, Preformed Pipe, Type I: 1-inch (25 mm) thick.
- B. Domestic Hot-Water Supply and Return, 140°F and below:
1. NPS 1¼ (DN 30) and Smaller: Insulation shall be Mineral-Fiber, Preformed Pipe, Type I, 1-inch thick.
 2. NPS 1½ (DN 40) and Larger: Insulation shall be Mineral-Fiber, Preformed Pipe, Type I, 1-1/2 inches thick.

- C. Domestic Water Branch Piping to Fixtures within Walls/Chases (Hot and Cold; Non-Recirculated):
 - 1. NPS 2 (DN 50) and Smaller: Insulation shall be Mineral-Fiber, Preformed Pipe, Type I, 1/2-inch thick.
 - 2. NPS 2 (DN 50) and smaller: Insulation shall be flexible elastomeric, 1/2 inch thick.
- D. Domestic Hot-Water Supply and Return, above 140°F:
 - 1. NPS 1-½ (DN 40) and Smaller: Insulation shall be Mineral-Fiber, Preformed Pipe, Type I, 1½-inch thick.
 - 2. NPS 2 (DN 50) and larger: Insulation shall be mineral fiber, preformed pipe type I, 2" thick.
- E. Storm Piping (including drain body and overflow storm piping)
 - 1. NPS-ALL: Insulation shall be mineral fiber, preformed pipe, Type I, 1" thick.
- F. Sanitary Waste Piping where heat tracing is installed.
 - 1. All Pipe Sizes: Insulation shall be mineral fiber preformed pipe insulation, Type I: 2" thick.

3.13 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

THISPAGELEFT INTENTIONALLY BLANK

SECTION 22 1116
DOMESTIC WATER PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- 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.

1.02 SUMMARY

- A. Section Includes:
 - 1. Copper tube and fittings.
 - 2. CPVC piping.
 - 3. PVC pipe and fittings.
 - 4. Piping joining materials.
 - 5. Encasement for piping.
 - 6. Transition fittings.
 - 7. Dielectric fittings.

1.03 ACTION SUBMITTALS

- A. Product Data: For transition fittings and dielectric fittings.
- B. Sustainable Design Submittals:
 - 1. Product Data: For adhesives, indicating VOC content.
 - 2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.

1.04 INFORMATIONAL SUBMITTALS

- A. System purging and disinfecting activities report.
- B. Field quality-control reports.

1.05 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

2.01 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.

2.02 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) water tube, drawn temper.
- B. Soft Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) and ASTM B 88, Type L (ASTM B 88M, Type B) water tube, annealed temper.

- C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- F. Copper Unions:
 - 1. MSS SP-123.
 - 2. Cast-copper-alloy, hexagonal-stock body.
 - 3. Ball-and-socket, metal-to-metal seating surfaces.
 - 4. Solder-joint or threaded ends.
- G. Copper Pressure-Seal-Joint Fittings:
 - 1. Fittings for NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
 - 2. Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
- H. Copper-Tube, Extruded-Tee Connections:
 - 1. Description: Tee formed in copper tube according to ASTM F 2014.
- I. Appurtenances for Grooved-End Copper Tubing:
 - 1. Bronze Fittings for Grooved-End, Copper Tubing: ASTM B 75/B 75M copper tube or ASTM B 584 bronze castings.
 - 2. Mechanical Couplings for Grooved-End Copper Tubing:
 - a. Copper-tube dimensions and design similar to AWWA C606.
 - b. Ferrous housing sections.
 - c. EPDM-rubber gaskets suitable for hot and cold water.
 - d. Bolts and nuts.
 - e. Minimum Pressure Rating: 300 psig (2070 kPa).

2.03 DUCTILE-IRON PIPE AND FITTINGS

- A. Standard-Pattern, Mechanical-Joint Fittings:
 - 1. AWWA C110/A21.10, ductile or gray iron.
 - 2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- B. Compact-Pattern, Mechanical-Joint Fittings:
 - 1. AWWA C153/A21.53, ductile iron.
 - 2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- C. Standard-Pattern, Push-on-Joint Fittings:
 - 1. AWWA C110/A21.10, ductile or gray iron.
 - 2. Gaskets: AWWA C111/A21.11, rubber.
- D. Compact-Pattern, Push-on-Joint Fittings:
 - 1. AWWA C153/A21.53, ductile iron.
 - 2. Gaskets: AWWA C111/A21.11, rubber.

2.04 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials:
 - 1. AWWA C110/A21.10, rubber, flat face, 1/8 inch (3.2 mm) 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.

- E. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.05 ENCASEMENT FOR PIPING

- A. Standard: ASTM A 674 or AWWA C105/A21.5.
- B. Form: tube.
- C. Color: Black or natural.

2.06 TRANSITION FITTINGS

- A. General Requirements:
 - 1. Same size as pipes to be joined.
 - 2. Pressure rating at least equal to pipes to be joined.
 - 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Sleeve-Type Transition Coupling: AWWA C219.
- D. Plastic-to-Metal Transition Fittings:
 - 1. Description:
 - a. One end with threaded brass insert and one solvent-cement-socket or threaded end.
- E. Plastic-to-Metal Transition Unions:
 - 1. Description:
 - a. Brass or stainless-steel threaded end.
 - b. Rubber O-ring.
 - c. Union nut.

2.07 DIELECTRIC FITTINGS

- A. See Section 22 0500 "Basic Plumbing Materials and Methods".

PART 3 - EXECUTION

3.01 EARTHWORK

- A. Comply with requirements in Section 31 2000 "Earth Moving" for excavating, trenching, and backfilling.

3.02 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 22 0519 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 22 1119 "Domestic Water Piping Specialties."
- D. Install shutoff valve immediately upstream of each dielectric fitting.
- E. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 22 1119 "Domestic Water Piping Specialties."
- F. Install domestic water piping with 0.25 percent slope downward toward drain level without pitch and plumb.

- G. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- H. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices in Section 20 0800 "Seismic Protection."
- I. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- J. 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.
- K. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- L. Install piping to permit valve servicing.
- M. 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.
- N. Install piping free of sags and bends.
- O. Install fittings for changes in direction and branch connections.
- P. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- Q. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Section 22 0519 "Meters and Gages for Plumbing Piping."
- R. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 22 1123 "Domestic Water Pumps."
- S. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 22 0519 "Meters and Gages."
- T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 0500 "Basic Plumbing Materials and Methods."
- U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 0500 "Basic Plumbing Materials and Methods." Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 0500 "Basic Plumbing Materials and Methods."

3.03 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Braze Joints" chapter.
- E. 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."

- F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.
- G. Push-on Joints for Copper Tubing: Clean end of tube. Measure insertion depth with manufacturer's depth gage. Join copper tube and push-on-joint fittings by inserting tube to measured depth.
- H. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.
- I. Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints according to AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
- J. Joint Construction for Grooved-End Steel Piping: Make joints according to AWWA C606. Roll groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
- K. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- L. Joint Construction for Solvent-Cemented Plastic Piping: 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. Apply primer.
 - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 - 3. PVC Piping: Join according to ASTM D 2855.
- M. Joints for PEX Tubing: Join according to ASTM F 1807 for metal insert and copper crimp ring fittings and ASTM F 1960 for cold expansion fittings and reinforcing rings.
- N. Joints for PEX Tubing: Join according to ASSE 1061 for push-fit fittings.
- O. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.04 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
 - 1. Fittings for NPS 1-1/2 (DN 40) and Smaller: Fitting-type coupling.
 - 2. Fittings for NPS 2 (DN 50) and Larger: Sleeve-type coupling.
- C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 (DN 50) and Smaller: Plastic-to-metal transition fittings or unions.

3.05 DIELECTRIC FITTING INSTALLATION

- A. See Section 22 0500 "Basic Plumbing Material and Methods".

3.06 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. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
 2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
 4. 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 (DN 65) and larger.

3.07 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 22 0553 "Identification for Plumbing Piping and Equipment."
- B. Label pressure piping with system operating pressure.

3.08 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 (345 kPa) 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.

3.09 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. Open throttling valves to proper setting.
 - 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
 - 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
 - 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 - 7. Remove filter cartridges from housings and verify that cartridges are as specified for application, where used and are clean and ready for use.
 - 8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.10 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:
 - 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 - 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) 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 (200 mg/L) 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. Clean non-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 procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.11 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 2 (DN 50) and smaller shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); cast-or wrought-copper, solder-joint fittings; and soldered joints.
2. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); copper pressure-seal-joint fittings; and pressure-sealed joints.
3. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); copper push-on-joint fittings; and push-on joints.

3.12 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 (DN 50) and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
 2. Throttling Duty: Use ball valves for piping NPS 2 (DN 50) and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
 3. Hot-Water Circulation Piping, Balancing Duty: Calibrated balancing valves.
 4. Drain Duty: Hose-end drain valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.
- C. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION

SECTION 22 1119
DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- 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.

1.02 SUMMARY

- A. Section Includes:
 - 1. Backflow preventers.
 - 2. Temperature-actuated, water mixing valves.
 - 3. Outlet boxes.
 - 4. Water-hammer arresters.
 - 5. Trap-seal primer valves.
 - 6. Trap-seal primer systems.
- 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.
 - 3. Section 224300 "Plumbing Fixtures" for thermostatic mixing valves for sitz baths, thermostatic mixing-valve assemblies for hydrotherapy equipment, and outlet boxes for dialysis equipment.

1.03 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.

1.04 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. Potable-water piping and components shall comply with NSF 61 Annex G and NSF 14. Mark "NSF-pw" on plastic piping components.

2.02 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig (860 kPa) unless otherwise indicated.

2.03 BACKFLOW PREVENTERS

- A. Reduced-Pressure-Principle Backflow Preventers:
 - 1. Acceptable manufacturers: WATTS, Febco, Ames and Wilkins.
 - 2. Standard: ASSE 1013.
 - 3. Operation: Continuous-pressure applications.

4. Pressure Loss: 12 psig (83 kPa) maximum, through middle third of flow range.
5. Size: See drawings.
6. Accessories:
 - a. Valves NPS 2 (DN 50) and Smaller: Ball type with threaded ends on inlet and outlet.
 - b. Valves NPS 2-1/2 (DN 65) and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
 - c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

2.06 TEMPERATURE-ACTUATED, WATER MIXING VALVES

- A. 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 (860 kPa) 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

2.07 TRAP-SEAL PRIMER DEVICE

- A. Supply-Type, Trap-Seal Primer Device:
 1. Acceptable manufacturers: PPP Inc., Sioux Chief and WATTS.
 2. Standard: ASSE 1018.
 3. Pressure Rating: 125 psig (860 kPa) minimum.
 4. Body: Bronze.
 5. Inlet and Outlet Connections: NPS 1/2 (DN 15) threaded, union, or solder joint.
 6. Gravity Drain Outlet Connection: NPS 1/2 (DN 15) threaded or solder joint.
 7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

2.08 FLEXIBLE CONNECTORS

- A. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
 1. Working-Pressure Rating: Minimum 200 psig (1380 kPa).
 2. End Connections NPS 2 (DN 50) and Smaller: Threaded copper pipe or plain-end copper tube.
 3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged copper alloy.
- B. 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 (1380 kPa).
 2. End Connections NPS 2 (DN 50) and Smaller: Threaded steel-pipe nipple.
 3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged steel nipple.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 1. Locate backflow preventers in same room as connected equipment or system.
 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.

3. Do not install bypass piping around backflow preventers.
- B. Install pressure gages on inlet and outlet of water regulator.
- C. 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.
- D. Install water-hammer arresters in water piping according to PDI-WH 201.
- E. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

3.02 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.

3.03 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. Reduced-pressure-principle backflow preventers.
- 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."

3.04 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 1. Test each reduced-pressure-principle backflow preventer 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.

3.05 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION

THISPAGELEFT INTENTIONALLY BLANK

SECTION 22 1316
SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- 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.

1.02 SUMMARY

- A. Section Includes:
 - 1. Pipe, tube, and fittings.
 - 2. Specialty pipe fittings.
 - 3. Encasement for underground metal piping.
- B. Related Requirements:
 - 1. Section 22 1329 "Sanitary Sewerage Pumps" for effluent and sewage pumps.
 - 2. Section 22 6600 "Chemical-Waste Systems for Laboratory and Healthcare Facilities" for chemical-waste and vent piping systems.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. Product Data for Credit IEQ 4.1: For solvent cements and adhesives, and primers, documentation including printed statement of VOC content.
 - 2. Laboratory Test Reports for credit IEQ 4: For solvent cements and adhesive primers documentation indicating that products comply with the testing and product requirements for the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers".

1.04 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.

1.05 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


2.01 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 (30 kPa).
- 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.

2.02 PIPING MATERIALS

- A. All cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI)  and listed by NSF International.
- 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".

2.03 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 and CISPI 301.
- B. Tensile Strength: 21,000 psig minimum.
- C. Pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute  and listed by NSF International.
- D. Each length of pipe and each fitting shall be plainly marked with size, country of origin, and name of manufacturer, or manufacturer's registered trademark by which the manufacturer can be readily identified after installation.
- E. Heavy-Duty, Hubless-Piping Couplings:
 - 1. Standards: ASTM C 1540, heavy duty, FM 1680 Class1.
 - 2. Description: Shield Assemblies shall consist of stainless-steel bi-directional corrugated shield (min. 28 gauge) with stainless-steel bands and 305 stainless-steel tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
 - 3. 1 1/2" to 4" utilize four band; 6" to 15" utilize six band.
 - a. Manufacturers:
 - 1) Husky SD 4000
 - 2) Clamp-All Corp-125

2.04 COPPER TUBE AND FITTINGS

- A. Copper Type DWV Tube: ASTM B 306, drainage tube, drawn temper.
- B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
- C. Hard Copper Tube: ASTM B 88, Type L and Type M (ASTM B 88M, Type B and Type C), water tube, drawn temper.
- D. Soft Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B), water tube, annealed temper.
- E. Copper Pressure Fittings:
 - 1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - 2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- F. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
 - 1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
 - 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

- G. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.05 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."

2.06 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.
 4. Pressure Transition Couplings:
 - a. Acceptable manufacturers; Jomar Industries, Mega-Coupling and Dresser.
 - b. Standard: AWWA C219.
 - c. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
 - d. Center-Sleeve Material: Manufacturer's standard.
 - e. Gasket Material: Natural or synthetic rubber.
 - f. Metal Component Finish: Corrosion-resistant coating or material.

- B. Dielectric Fittings:
 - 1. See Section 22 0500 "Basic Plumbing Materials and Methods".

PART 3 - EXECUTION

3.01 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 31 2000 "Earth Moving."

3.02 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 20 0800 "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 drainpipe.
 - 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. Lay buried building waste piping beginning at low point of each system.
 - 1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
 - 2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
 - 3. Maintain swab in piping and pull past each joint as completed.
- L. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Sanitary Waste: 2 percent downward in direction of flow for piping NPS 2 and smaller; 2 percent downward in direction of flow for piping NPS 3 and larger.
 - 2. Horizontal Sanitary Waste Piping: 2 percent downward in direction of flow.
 - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

- M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.
- N. Install steel piping according to applicable plumbing code.
- O. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
- P. Install aboveground PVC piping according to ASTM D 2665.
- Q. Install underground PVC piping according to ASTM D 2321.
- R. Install engineered soil and waste and vent piping systems as follows:
 - 1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
 - 2. Hubless, Single-Stack Drainage System: Comply with ASME B16.45 and hubless, single-stack aerator fitting manufacturer's written installation instructions.
 - 3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.
- S. Install force mains at elevations indicated.
- T. Plumbing Specialties:
 - 1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.
 - a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
 - b. Comply with requirements for cleanouts specified in Section 22 1319 "Sanitary Waste Piping Specialties."
 - 2. Install drains in sanitary waste gravity-flow piping.
 - a. Comply with requirements for drains specified in Section 22 1319 "Sanitary Waste Piping Specialties."
- U. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- V. Install sleeves for piping penetrations of walls, ceilings, and floors.
 - 1. Comply with requirements for sleeves specified in Section 22 0500 "Basic Plumbing Material and Methods."
- W. Install sleeve seals for piping penetrations of concrete walls and slabs.
 - 2. Comply with requirements for sleeve seals specified in Section 22 0500 "Basic Plumbing Material and Methods."
 - 1. Install escutcheons for piping penetrations of walls, ceilings, and floors.
 - 1. Comply with requirements for escutcheons specified in Section 22 0500 "Basic Plumbing Material and Methods."

3.03 JOINT CONSTRUCTION

- A. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- B. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.
- C. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.
- D. 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.

3.04 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, non-pressure transition couplings.
 - 3. In Aboveground Force Main Piping: Fitting-type transition couplings.
 - 4. In Underground Force Main Piping:
 - a. NPS 1-1/2 (DN 40) and Smaller: Fitting-type transition couplings.
 - b. NPS 2 (DN 50) and Larger: Pressure transition couplings.
- B. Dielectric Fittings:
 - 1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
 - 2. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric unions.
 - 3. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100) Use dielectric flanges, flange kits, and nipples.

3.05 VALVE INSTALLATION

- A. Comply with requirements in Section 22 0523 "Valves", for general-duty valve installation requirements.
- B. Shutoff Valves:
 - 1. Install shutoff valve on each sewage pump discharge.
 - 2. Install gate or full-port ball valve for piping NPS 3 and smaller.
- C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.
- D. Backwater Valves: Install backwater valves in piping subject to backflow.
 - 1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
 - 2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
 - 3. Install backwater valves in accessible locations.
 - 4. Comply with requirements for backwater valve specified in Section 22 1319 "Sanitary Waste Piping Specialties."

3.06 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices specified in Section 20 0800 "Seismic Protection".
- B. Comply with requirements for pipe hanger and support devices and installation specified in Section 22 0529 "Hangers and Supports for Plumbing Piping and Equipment." Section 20 0800 "Seismic Protection."

3.07 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 22 1319 "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 (DN 65) 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 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
 2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.08 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping.
- B. Comply with requirements for identification specified in Section 22 0500 "Basic Plumbing Materials and Methods".

3.09 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 (30 kPa).
 - 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 (250 Pa).
 - 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.
- E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
 2. Cap and subject piping to static-water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials.
 - a. Isolate test source and allow to stand for four hours.
 - b. Leaks and loss in test pressure constitute defects that must be repaired.
 3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 4. Prepare reports for tests and required corrective action.

3.10 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.

3.11 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 4 (DN 100) and smaller shall be any of the following:
 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings and hubless, heavy-duty hubless-piping couplings; and coupled joints.
 3. Copper Type DWV tube, copper drainage fittings, and soldered joints.
 4. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 5. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- C. Aboveground, vent piping NPS 4 (DN 100) and smaller shall be any of the following:
 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
 3. Copper Type DWV tube, copper drainage fittings, and soldered joints.
 - a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2 (DN 65 and DN 90): Hard copper tube, Type M (Type C); copper pressure fittings; and soldered joints.
 4. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 5. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

END OF SECTION

SECTION 22 1319
SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- 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.

1.02 SUMMARY

- A. Section Includes:
 - 1. Cleanouts.
 - 2. Through-penetration firestop assemblies.
 - 3. Miscellaneous sanitary drainage piping specialties.
 - 4. Floor drains.
- B. Related Requirements:
 - 1. Section 22 1423 "Storm Drainage Piping Specialties" for trench drains for storm water, channel drainage systems for storm water, roof drains, and catch basins.

1.03 DEFINITIONS

- A. PVC: Polyvinyl chloride.
- B. FRP: Fiberglass-reinforced plastic.
- C. HDPE: High-density polyethylene.
- D. PE: Polyethylene.
- E. PP: Polypropylene.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include rated capacities, operating characteristics, and accessories for the following:
 - 1. FOG disposal systems.
- B. Shop Drawings:
 - 1. Show fabrication and installation details for frost-resistant vent terminals.

1.05 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For FOG disposal 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.
- B. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For sanitary waste piping specialties to include in emergency, operation, and maintenance manuals.

1.07 BUY AMERICAN ACT

- A. The Contractor shall use only domestic construction materials and components in performing under these specifications in accordance with the Buy American Act (41 USC 10a-10d) or shall submit waivers for same as permitted thereunder.
- B. Each material or component must be manufactured in the United States and the cost of the domestic sub-components must exceed 50% of the cost of all the components unless one or more exceptions apply under the Buy American Act.
- C. Comply by either certifying that the materials purchased for the project meet the criteria or apply for a waiver. Document compliance by one of these methods as part of each product's shop drawing submittal.

PART 2 - PRODUCTS

2.01 ASSEMBLY DESCRIPTIONS

- A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary waste piping specialty components.
- 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.

2.02 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: Hubless, cast-iron soil pipe test tee 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. Stainless-Steel Exposed Cleanouts:
 - 1. Approved manufacturers are J. R. Smith, Josam, and Zurn.
 - 2. Standard: ASME A112.3.1.
 - 3. Size: Same as connected drainage piping
 - 4. Body Material: Stainless-steel tee with side cleanout as required to match connected piping.
 - 5. Closure: Stainless-steel plug with seal.

2.03 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 (DN 50): 4-inch- (100-mm-) minimum water seal.
 - b. NPS 2-1/2 (DN 65) and Larger: 5-inch- (125-mm-) minimum water seal.
- B. Floor-Drain, Trap-Seal Primer Fittings:
 - 1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
 - 2. Size: Same as floor drain outlet with NPS 1/2 (DN 15) side inlet.
- C. Sleeve Flashing Device:
 - 1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch (25 mm) above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.

2. Size: As required for close fit to riser or stack piping.

2.04 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.

2.05 FLOOR DRAINS

- A. Cast-Iron Floor Drains.
 1. Approved manufacturers are Josam, J. R. Smith and Zurn.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 1. Size same as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) 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 (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.
 4. Locate at base of each vertical soil and waste stack.
- B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- D. 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."
- E. 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."
- F. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.
 1. Comply with requirements in Section 078413 "Penetration Firestopping."
- G. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- H. 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.
- I. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- J. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.
- K. Install fire-rated wood-blocking reinforcement for wall-mounting-type specialties.
- L. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- M. 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 (750 mm) or Less: Equivalent to 1 percent slope, but not less than 1/4-inch (6.35-mm) total depression.
 - b. Radius, 30 to 60 Inches (750 to 1500 mm): Equivalent to 1 percent slope.
 - c. Radius, 60 Inches (1500 mm) or Larger: Equivalent to 1 percent slope, but not greater than 1-inch (25-mm) 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.
- N. Install trench drains at low points of surface areas to be drained.
 1. Set grates of drains flush with finished surface, unless otherwise indicated.
- O. 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.
- P. Install FRP channel drainage system components on support devices, so that top will be flush with adjacent surface.
- Q. Install plastic channel drainage system components on support devices, so that top will be flush with adjacent surface.

3.02 CONNECTIONS

- A. Comply with requirements in Section 22 1316 "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 26 0519 "Low-Voltage Electrical Power Conductors and Cables."
- E. Comply with requirements in Section 22 1319 "Sanitary Waste Piping Specialties" for backwater valves, air admittance devices and miscellaneous sanitary drainage piping specialties.

3.03 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 (250 mm), and skirt or flange extending at least 8 inches (200 mm) around pipe.
 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around sleeve.
 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) 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 07 6200 "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.

3.04 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."

3.05 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

THISPAGELEFT INTENTIONALLY BLANK

SECTION 22 1413
STORM DRAINAGE PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- 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.

1.02 SUMMARY

- A. Section Includes:
 - 1. Pipe, tube, and fittings.
 - 2. Specialty pipe fittings.
 - 3. Encasement for underground metal piping.
- B. Related Sections:
 - 1. Section 22 1429 "Sump Pumps" for storm drainage pumps.
 - 2. Section 22 0500 "Basic Plumbing Materials and Methods" for transition couplings and dielectric fittings.

1.03 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Storm Drainage Piping: 10-foot head of water.
 - 2. Storm Drainage, Force-Main Piping: 50 psig.
- B. Seismic Performance: Storm drainage piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Sustainable Design Submittals:
 - 1. Product Data for Credit IEQ 4.1: For solvent cements and adhesives, and primers, documentation including printed statement of VOC content.
 - 2. Laboratory Test Reports for credit IEQ 4: For solvent cements and adhesive primers documentation indicating that products comply with the testing and product requirements for the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers".

1.05 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For storm drainage 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 equipment anchorage devices on which the certification is based and their installation requirements.
- B. Field quality-control reports.

1.06 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

- B. Comply with NSF/ANSI 14, "Plastics Piping System Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

1.07 PROJECT CONDITIONS

- A. Interruption of Existing Storm-Drainage 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 storm-drainage service.
 - 2. Do not proceed with interruption of storm-drainage service without Owner's written permission.

PART 2 - PRODUCTS

2.01 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.

2.02 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 and CISPI 301.
- B. Heavy-Duty, Hubless-Piping Couplings:
 - 1. Standards: ASTM C 1277 and ASTM C 1540.
 - 2. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
- C. Cast-Iron, Hubless-Piping Couplings:
Standard: ASTM C 1277.
 - 1. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.03 SPECIALTY PIPE FITTINGS

- A. Transition couplings:
 - 1. See section 22 0500 "Basic Plumbing Materials and Methods".
- B. Dielectric Fittings:
 - 1. See section 22 0500 "Basic Plumbing Materials and Methods".

PART 3 - EXECUTION

3.01 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.02 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations from 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 20 0800 "Seismic Protection."
- K. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- L. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- M. Install storm drainage piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Storm Drain: 2 percent downward in direction of flow for piping NPS 3 (DN 80) and smaller; 1 percent downward in direction of flow for piping NPS 4 (DN 100) and larger.
 - 2. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.
- N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.
- O. Install steel piping according to applicable plumbing code.
- P. Join copper tube and fittings with soldered joints according to ASTM B 828 procedure. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.
- Q. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fittings. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.
- R. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.
- S. Plastic, Non-pressure-Piping, Solvent-Cemented 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 Appendices.

3.03 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
 - 1. Install transition couplings at joints of piping with small differences in ODs.
 - 2. In Drainage Piping: Unshielded or Shielded, nonpressure transition couplings.
 - 3. In Aboveground Force-Main Piping: Fitting-type transition couplings.
 - 4. In Underground Force-Main Piping:
 - a. NPS 1-1/2 (DN 40) and Smaller: Fitting-type transition couplings.
 - b. NPS 2 (DN 50) and Larger: Pressure transition couplings.
- B. Dielectric Fittings:
 - 1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

2. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric nipples or unions.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges or flange kits.
4. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.04 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect storm drainage piping to roof drains and storm drainage specialties.
 1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
 2. Comply with requirements for cleanouts specified in Section 221423 "Storm Drainage Piping Specialties."
- 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 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
 2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.05 IDENTIFICATION

- A. Identify exposed storm drainage piping. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.06 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.
 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 storm drainage 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. 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 storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 3. Test Procedure: Test storm drainage piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
 4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 5. Prepare reports for tests and required corrective action.

- E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 2. Cap and subject piping to static-water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - 3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 4. Prepare reports for tests and required corrective action.

3.07 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains 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.

3.08 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground storm drainage piping NPS 6 (DN 150) and smaller shall be one of the following:
 - 1. Hubless, cast-iron soil pipe and fittings; heavy-duty, hubless-piping couplings; and coupled joints.
 - 2. Dissimilar Pipe-Material Couplings: Unshielded or Shielded, nonpressure transition couplings.

END OF SECTION

THISPAGELEFT INTENTIONALLY BLANK

**SECTION 22 4300
PLUMBING FIXTURES**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- 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.

1.02 SUMMARY

- A. Section includes the following fixtures and specialties:
 - 1. Water closets.
 - 2. Flushometer valves.
 - 3. Toilet seats.
 - 4. Sinks.
 - 5. Supports.
 - 6. Lavatories.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fixtures.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Sustainable Design Submittals.
- C. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.04 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 01 7823 "Operation and Maintenance Data," include the following:
 - a. Servicing and adjustments of flushometer valves, electronic sensors.

1.05 BUY AMERICAN ACT

- A. The Contractor shall use only domestic construction materials and components in performing under these specifications in accordance with the Buy American Act (41 USC 10a-10d) or shall submit waivers for same as permitted thereunder.
- B. Each material or component must be manufactured in the United States and the cost of the domestic sub-components must exceed 50% of the cost of all the components unless one or more exceptions apply under the Buy American Act.
- C. Comply by either certifying that the materials purchased for the project meet the criteria or apply for a waiver. Document compliance by one of these methods as part of each product's shop drawing submittal.

PART 2 - PRODUCTS

2.01 WATER CLOSETS

- A. Water Closets.
 - 1. Acceptable manufacturers: Kohler, American Standard and Sloan.

2.02 FLUSH VALVES

- A. Flush valves.
 - 1. Acceptable manufacturers: Sloan, Zurn and Moen.

2.03 LAVATORIES

- A. Lavatories.
 - 1. Acceptable manufacturers: Kohler, American Standard and Sloan.

2.04 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".

2.05 TOILET SEATS

- A. Toilet Seats.
 - 1. Acceptable manufacturers: Bemis, Church, and Beneke.

2.06 BATHTUB & SHOWER FAUCETS

- A. Bathtub & shower faucets.
 - 1. Acceptable manufacturers: Powers, Symmons, Zurn, Acorn and Bradley

2.07 SERVICE SINKS

- A. Service sinks.
 - 1. Acceptable manufacturers: Fiat, Stern Williams, and E.L. Mustee & Sons.

2.08 PLASTER SINKS

- A. Plaster Sinks.
 - 1. Acceptable manufacturers: Just, Elkay and Advance Tabco.

2.09 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 SUPPORTS (CARRIERS)

- A. Supports (carriers).
 - 1. Acceptable manufacturers: Zurn, Josam and Jay R. Smith.

2.12 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 (DN 15) chrome-plated, rigid-copper pipe and brass straight or offset tailpieces.

2.13 WASTE FITTINGS

- A. Waste fittings
 - 1. Acceptable manufacturers: Keeney Mfg, Wolverine Brass and Dearborn Brass.

2.14 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

3.01 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.

3.02 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 floor-mounted water closets on bowl-to-drain, connecting fitting attachments to piping or building substrate.
- D. Install counter-mounted fixtures in and attached to casework.
- E. 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 22 0523 "Ball Valves."
- F. Install flushometer valves on water closets & urinals.
- G. Install flushometer valves for accessible water closets & urinals with lever handle mounted on wide side of compartment.
- H. Install toilet seats on water closets.
- I. 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.

- J. Install laminar-flow, faucet-spout fittings in faucet spouts where laminar-flow fittings are specified.
- 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 22 0719 "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 07 9200 "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 22 0500 "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.

3.03 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 22 1116 "Domestic Water Piping."
- C. Comply with requirements for soil and waste drainage piping and vent piping specified in Section 22 1316 "Sanitary Waste and Vent Piping."
- D. Comply with requirements for atmospheric vent piping specified in Section 22 1316 "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 22 0719 "Plumbing Piping Insulation."

3.04 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.

3.05 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

SECTION 22 6113

COMPRESSED-AIR PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- 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.

1.02 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. Retain subparagraphs below to cross-reference requirements Contractor might expect to find in this Section but are specified elsewhere.
 - 2. Section 11 5313 "Laboratory Fume Hoods" for compressed-air outlets in laboratory fume hoods.
 - 3. Section 12 3553 "Laboratory Casework" for compressed-air outlets in laboratory casework.
 - 4. Section 12 3570 "Healthcare Casework" for compressed-air outlets in healthcare casework.
 - 5. Section 22 1513 "General-Service Compressed-Air Piping" for general-service compressed-air piping and specialties.
 - 6. Section 22 6119 "Compressed-Air Equipment for Laboratory and Healthcare Facilities" for air compressors and specialties.
 - 7. Section 22 6400 "Medical Gas Alarms" for combined medical air, vacuum, and gas alarms.

1.03 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.

1.04 ACTION SUBMITTALS

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

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and testing agency.
- B. Seismic Qualification Certificates: For medical compressed-air manifolds, 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. Material Certificates: Signed by Installer certifying that medical compressed-air piping materials comply with requirements in NFPA 99 for positive-pressure medical gas systems.
- D. Brazing certificates.
- E. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For compressed-air piping specialties to include in emergency, operation, and maintenance manuals.

1.07 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

2.01 SYSTEM DESCRIPTION

- A. Medical air operating at 50 to 55 psig (345 to 380 kPa).
- B. Instrument air operating at 175 psig (1200 kPa).

2.02 PIPES, TUBES, AND FITTINGS

- A. Comply with NFPA 99 for medical air piping materials.
- B. Comply with ASME B31.1, "Power Piping," for laboratory air piping operating at more than 150 psig (1035 kPa).
- C. Comply with ASME B31.9, "Building Services Piping," for laboratory air piping operating at 150 psig (1035 kPa) or less.
- D. Copper Medical Gas Tube: ASTM B 819, Type K, 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.
- E. 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.
- F. Copper Unions: ASME B16.22 or MSS SP-123, wrought-copper or cast-copper alloy.
- G. 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.
- H. Flexible Pipe Connectors:

1. Description: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
 - a. Working-Pressure Rating: 200 psig (1380 kPa) minimum.
 - b. End Connections: Plain-end copper tube.
 - c. Cleaned, purged and sealed for oxygen service according to CGA G-4.1.

2.03 JOINING MATERIALS

- A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.
- B. Threaded-Joint Tape: PTFE.

2.04 VALVES

- A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
- B. Zone-Valve Box Assemblies: Box with medical gas valves, tube extensions, and gages.
 1. Zone-Valve Boxes:
 - a. Steel Box with Aluminum Cover:
 - 1) Acceptable manufacturers: Beacon Medaes, Amico and Chemetron.
 - b. Steel Box with Stainless-Steel Cover:
 - 1) Acceptable manufacturers: Beacon Medaes, Amico and Chemetron.
 - c. Description: Formed steel box with cover, anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves. Medical air and medical vacuum tubing, valves, and gages may be incorporated in zone valve boxes for medical gases.
 - 1) Interior Finish: Factory-applied white enamel.
 - 2) Cover Plate: Aluminum or stainless-steel with frangible or removable windows.
 - 3) Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.
- C. 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 type with locking device.
 8. Stem: Blowout proof with PTFE or TFE seal.
 9. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions and manufacturer-installed ASTM B 819, copper-tube extensions with pressure gage on one copper-tube extension.
- D. Check Valves:
 1. Acceptable manufacturers: Beacon Medaes, Amico and Chemetron.
 2. Description: In-line pattern, bronze.
 3. Pressure Rating: 300 psig (2070 kPa) minimum.
 4. Operation: Spring loaded.
 5. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- E. Safety Valves:
 1. Bronze body.
 2. ASME-construction, poppet, pressure-relief type.
 3. Settings to match system requirements.

- F. 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.

2.05 MEDICAL COMPRESSED-AIR SERVICE CONNECTIONS

- A. Acceptable manufacturers: Beacon Medaes, Amico and Chemetron.
- B. General Requirements for Medical Compressed-Air Service Connections:
 - 1. Suitable for specific medical air pressure and service listed.
 - 2. Include roughing-in assemblies, finishing assemblies, and cover plates.
 - 3. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate.
 - 4. Recessed-type units made for concealed piping unless otherwise indicated.
- C. Roughing-in Assembly:
 - 1. Steel outlet box for recessed mounting and concealed piping.
 - 2. Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed.
 - 3. Double seals that will prevent air leakage.
 - 4. ASTM B 819, NPS 3/8 (DN 10) copper outlet tube brazed to valve with service marking and tube-end dust cap.
- D. Finishing Assembly:
 - 1. Brass housing with primary check valve.
 - 2. Double seals that will prevent air leakage.
 - 3. Cover plate with gas-service label.
- E. Quick-Coupler Pressure Service Connections:
 - 1. Outlets for medical air and instrument air with noninterchangeable keyed indexing to prevent interchange between services.
 - 2. Constructed to permit one-handed connection and removal of equipment.
 - 3. With positive-locking ring that retains equipment stem in valve during use.
- F. D.I.S.S. Pressure Service Connections: Outlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.
 - 1. Medical Air: D.I.S.S. No. 1160.
 - 2. Instrument Air: D.I.S.S. No. 1160.
- G. Cover Plates:
 - 1. One piece.
 - 2. Aluminum or stainless-steel.
 - 3. Permanent, color-coded, identifying label matching corresponding service.

PART 3 - EXECUTION

3.01 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.

3.02 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 22 0519 "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 22 6313 "Gas Piping for Laboratory and Healthcare Facilities," and to equipment specified in other Sections requiring medical air service.
- P. Piping Restraint Installation: Install seismic restraints on compressed-air piping. Seismic-restraint devices are specified in Section 20 0800 "Seismic Protection"
- Q. Install compressed-air service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
- R. Connect compressed-air piping to air compressors and to compressed-air outlets and equipment requiring compressed-air service.

- S. Install unions in copper compressed-air tubing adjacent to each valve and at final connection to each machine, specialty, and piece of equipment.
- T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 0500 "Basic Plumbing Materials and Methods."
- U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 0500 "Basic Plumbing Materials and Methods."

3.03 VALVE INSTALLATION

- A. Install shutoff valve at each connection to and from compressed-air equipment and specialties.
- B. Install check valves to maintain correct direction of compressed-air flow from compressed-air equipment.
- C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
- D. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.
- E. Install pressure regulators on compressed-air piping where reduced pressure is required.
- F. Install flexible pipe connectors in discharge piping and in inlet air piping from remote air-inlet filter of each air compressor.

3.04 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," "Braze Joints" chapter. Continuously purge joint with oil-free dry nitrogen during brazing.
- D. Flanged Joints: Install flange on copper tubes. Use pipe-flange gasket between flanges. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.
- E. Shape-Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of shape-memory-metal coupling joints.

3.05 COMPRESSED-AIR SERVICE COMPONENT INSTALLATION

- A. Install compressed-air pressure control panel in walls. Attach to substrate.
- B. Install compressed-air manifolds on concrete base anchored to substrate.
- C. Install compressed-air cylinders and connect to manifold piping.
- D. Install compressed-air manifolds with seismic restraints as indicated.
- E. Install compressed-air-cylinder wall storage racks attached to substrate.

3.06 IDENTIFICATION

- A. Install identifying labels and devices for nonmedical laboratory compressed-air piping, valves, and specialties. Comply with requirements in Section 22 0553 "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. Medical Air: Black letters on yellow background.
 - 2. Instrument Air: White letters on red background.

3.07 FIELD QUALITY CONTROL FOR MEDICAL COMPRESSED-AIR PIPING IN HEALTHCARE FACILITIES

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections of medical compressed-air piping in healthcare facilities and to prepare test and inspection reports.
- B. Tests and Inspections:
 - 1. Medical Compressed-Air Testing Coordination: Perform tests, inspections, verifications, and certification of medical compressed-air piping systems concurrently with tests, inspections, and certification of medical gas piping and medical vacuum piping systems.
 - 2. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
 - a. Initial blowdown.
 - b. Initial pressure test.
 - c. Cross-connection test.
 - d. Piping purge test.
 - e. Standing pressure test for positive-pressure medical compressed-air piping.
 - f. Repair leaks and retest until no leaks exist.
 - 3. System Verification: Perform the following tests and inspections according to NFPA 99, ASSE Standard #6020, and ASSE Standard #6030:
 - a. Standing pressure test.
 - b. Individual-pressurization or pressure-differential cross-connection test.
 - c. Valve test.
 - d. Master and area alarm tests.
 - e. Piping purge test.
 - f. Piping particulate test.
 - g. Piping purity test.
 - h. Final tie-in test.
 - i. Operational pressure test.
 - j. Medical air purity test.
 - k. Verify correct labeling of equipment and components.
 - 4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
 - a. Inspections performed.
 - b. Procedures, materials, and gases used.
 - c. Test methods used.
 - d. Results of tests.
- C. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.08 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.

3.09 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.

3.10 PIPING SCHEDULE

- A. Connect new tubing to existing tubing with memory-metal couplings.
- B. Flanges may be used where connection to flanged equipment is required.
- C. Medical Air Piping except Instrument Air Piping NPS 3 (DN 80) and smaller Operating at More Than 185 psig (1275 kPa) or less: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
- D. Instrument Air Piping NPS 3 (DN 80) and smaller Operating at More Than 185 psig (1275 kPa): Type K, copper tube; wrought-copper fittings; and brazed joints.

3.11 VALVE SCHEDULE

- A. Shutoff Valves: Ball valve with manufacturer-installed ASTM B 819, copper-tube extensions.
- B. Zone Valves: Ball valve with manufacturer-installed ASTM B 819, copper-tube extensions with pressure gage on one copper-tube extension.

END OF SECTION

SECTION 22 6213

VACUUM PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- 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.

1.02 SUMMARY

- A. Section Includes:
 - 1. Medical-surgical vacuum piping, designated "medical vacuum."
 - 2. Waste anesthetic gas disposal piping, designated "WAGD."
 - 3. Dental vacuum piping, designated "dental vacuum (DV)."
 - 4. Healthcare laboratory vacuum piping, designated "medical laboratory vacuum."
 - 5. Laboratory low-vacuum piping, designated "laboratory low vacuum."
 - 6. Laboratory high-vacuum piping, designated "laboratory high vacuum."
- B. Related Requirements:
 - 1. Section 11 5313 "Laboratory Fume Hoods" for vacuum inlets in laboratory fume hoods.
 - 2. Section 12 3553 "Laboratory Casework" for vacuum inlets in laboratory casework.
 - 3. Section 12 3570 "Healthcare Casework" for vacuum inlets in healthcare casework.
 - 4. Section 22 6219 "Vacuum Equipment for Laboratory and Healthcare Facilities" for vacuum producers and accessories.
 - 5. Section 22 6400 "Medical Gas Alarms" for vacuum piping alarms.

1.03 DEFINITIONS

- A. WAGD: Waste anesthetic gas disposal.
- B. Medical vacuum piping systems include medical vacuum, WAGD, dental vacuum, HVE, and medical laboratory vacuum piping systems.
- C. Nonmedical laboratory vacuum piping systems include laboratory low-vacuum and laboratory high-vacuum piping systems.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. Product Data for Credit IEQ 4.1: For solvent cements and adhesives, and primers, documentation including printed statement of VOC content.
 - 2. Laboratory Test Reports for credit IEQ 4: For solvent cements and adhesive primers documentation indicating that products comply with the testing and product requirements for the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers".

1.05 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.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For vacuum piping specialties to include in emergency, operation, and maintenance manuals.

1.07 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

2.01 SYSTEM DESCRIPTION

- A. Medical vacuum operating at 15 in. Hg.
- B. WAGD operating at 14 in. Hg.

2.02 PIPES, TUBES, AND FITTINGS

- A. Comply with NFPA 99 for medical vacuum piping materials.
- B. 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.
- C. 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.
- D. Copper Unions: ASME B16.22 or MSS SP-123, wrought-copper or cast-copper alloy.
- E. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150.
 - 1. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness, full-face type.
 - 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.
- F. Flexible Pipe Connectors:
 - 1. Description: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
 - a. Working-Pressure Rating: 200 psig minimum.
 - b. End Connections: Plain-end copper tube.

2.03 JOINING MATERIALS

- A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.
- B. Threaded-Joint Tape: PTFE.

2.04 VALVES

- A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
 - 1. Exception: Factory cleaning and bagging are not required for valves for WAGD service.

- B. Zone-Valve Box Assemblies: Box with medical gas valves, tube extensions, and gages. Acceptable manufacturers: Beacon Medeas, Amico, and Chemetron.
1. Zone-Valve Boxes:
 - a. Steel Box with Aluminum Cover:
 - b. Steel Box with Stainless-Steel Cover:
 - c. Description: Formed steel box with cover, anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with vacuum gages and in sizes required to permit manual operation of valves.
 - 1) Interior Finish: Factory-applied white enamel.
 - 2) Cover Plate: Aluminum or stainless-steel with frangible or removable windows.
 - 3) Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.
- C. 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.
- D. Check Valves:
1. Acceptable manufacturers: Beacon Medeas, Amico, and Chemetron.
 2. Description: In-line pattern, bronze.
 3. Pressure Rating: 300 psig (2070 kPa) minimum.
 4. Operation: Spring loaded.
 5. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

2.05 MEDICAL VACUUM SERVICE CONNECTIONS

- A. Acceptable manufacturers: Beacon Medeas, Amico, and Chemetron.
- B. General Requirements for Medical Vacuum Service Connections:
1. Suitable for specific medical vacuum service listed.
 2. Include roughing-in assemblies, finishing assemblies, and cover plates.
 3. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate.
 4. Recessed-type units made for concealed piping unless otherwise indicated.
- C. Roughing-in Assembly:
1. Steel outlet box for recessed mounting and concealed piping.
 2. Brass-body inlet block.
 3. Seals that will prevent vacuum leakage.
 4. ASTM B 819, NPS 3/8 (DN 10) copper outlet tube brazed to valve with service marking and tube-end dust cap.
- D. Finishing Assembly:
1. Brass housing with primary check valve.
 2. Seals that will prevent vacuum leakage.
 3. Cover plate with gas-service label.

- E. Quick-Coupler Suction Service Connections:
 - 1. Inlets for medical vacuum and WAGD with noninterchangeable keyed indexing to prevent interchange between services.
 - 2. Constructed to permit one-handed connection and removal of equipment.
 - 3. With positive-locking ring that retains equipment stem in valve during use.
- F. D.I.S.S. Suction Service Connections:
 - 1. Inlets complying with CGA V-5.
 - 2. Threaded indexing to prevent interchange between services.
 - 3. Constructed to permit one-handed connection and removal of equipment.
 - 4. Medical Vacuum: CGA V-5, D.I.S.S. No. 1220.
 - 5. WAGD: CGA V-5, D.I.S.S. No. 2220.
- G. Vacuum Bottle Brackets: One piece, with pattern and finish matching corresponding service cover plate.
- H. Cover Plates:
 - 1. One piece.
 - 2. Aluminum or stainless-steel.
 - 3. Permanent, color-coded, identifying label matching corresponding service.

PART 3 - EXECUTION

3.01 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.

3.02 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 22 0519 "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 22 6219 "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 20 0800 "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 sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 0500 Basic Plumbing Materials and Methods."
- V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 0500 Basic Plumbing Materials and Methods."

3.03 VALVE INSTALLATION

- A. Install shutoff valve at each connection to and from vacuum equipment and specialties.
- B. Install check valves to maintain correct direction of vacuum flow to vacuum-producing equipment.
- C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
- D. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.
- E. Install flexible pipe connectors in suction inlet piping to each vacuum producer.

3.04 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," "Braze Joints" chapter. Do not use flux. Continuously purge joint with oil-free dry nitrogen during brazing.
- F. Flanged Joints:
 - 1. Copper Tubing: Install flange on copper tubes. Use pipe-flange gasket between flanges. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.

3.05 IDENTIFICATION

- A. Install identifying labels and devices for laboratory vacuum piping, valves, and specialties. Comply with requirements in Section 22 0500 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. Medical Vacuum: Black letters on white background.
 - 2. WAGD: White letters on violet background.
 - 3. Surgical Dental Vacuum: Black letters on white background.
 - 4. Dental Vacuum (DV): Black boxed letters on white-and-black diagonal stripe background.
 - 5. Medical Laboratory Vacuum: Black boxed letters on white-and-black checkerboard background.

3.06 FIELD QUALITY CONTROL FOR HEALTHCARE FACILITY MEDICAL VACUUM PIPING

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections of medical vacuum piping systems in healthcare facilities and to prepare test and inspection reports.
- B. Tests and Inspections:
 - 1. Medical Vacuum Testing Coordination: Perform tests, inspections, verifications, and certification of medical vacuum piping systems concurrently with tests, inspections, and certification of medical compressed-air piping and medical gas piping systems.
 - 2. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
 - a. Initial blowdown.
 - b. Initial pressure test.
 - c. Cross-connection test.
 - d. Piping purge test.
 - e. Standing pressure test for vacuum systems.
 - f. Repair leaks and retest until no leaks exist.
 - 3. System Verification: Perform the following tests and inspections according to NFPA 99, ASSE Standard #6020, and ASSE Standard #6030:
 - a. Standing pressure test.
 - b. Individual-pressurization or pressure-differential cross-connection test.
 - c. Valve test.
 - d. Master and area alarm tests.
 - e. Piping purge test.
 - f. Final tie-in test.
 - g. Operational vacuum test.
 - h. Verify correct labeling of equipment and components.
 - 4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
 - a. Inspections performed.
 - b. Procedures, materials, and gases used.
 - c. Test methods used.
 - d. Results of tests.

- C. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.07 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.
 - b. Test Pressure for PVC Piping: 50 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.

3.08 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.

3.09 PIPING SCHEDULE

- A. Connect new copper tubing to existing copper tubing with memory-metal couplings.
- B. Flanges may be used where connection to flanged equipment is required.
- C. Medical Vacuum Piping: Use copper medical gas tube, wrought-copper fittings, and brazed joints.
- D. WAGD Piping: Use copper medical gas tube, 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.
- B. Zone Valves: Oxygen cleaned and bagged copper-alloy ball valve with manufacturer-installed ASTM B 819, copper-tube extensions with pressure gage on one copper-tube extension.

END OF SECTION

THISPAGELEFT INTENTIONALLY BLANK

SECTION 22 6313

GAS PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- 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.

1.02 SUMMARY

- A. Section Includes:
 - 1. Oxygen piping, designated "medical oxygen."
- B. Owner-Furnished Material:
 - 1. Patient-service consoles.
 - 2. Ceiling columns.
 - 3. Ceiling-hose assemblies.
 - 4. Medical gas manifolds.
 - 5. Owner will furnish gases for medical gas concentration testing specified in this Section.
- C. Related Requirements:
 - 1. Section 12 3570 "Healthcare Casework" for gas outlets in medical casework.

1.03 DEFINITIONS

- A. CR: Chlorosulfonated polyethylene synthetic rubber.
- B. Medical gas piping systems include medical carbon dioxide, medical helium, medical nitrogen, medical nitrous oxide, and medical oxygen for healthcare facility patient care.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and testing agency.
- B. Material Certificates: Signed by Installer certifying that medical gas piping materials comply with requirements in NFPA 99 for positive-pressure medical gas systems.
- C. Brazing certificates.
- D. Certificates of Shop Inspection and Data Report for Bulk Gas Storage Tanks: As required by ASME Boiler and Pressure Vessel Code.
- E. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For medical and specialty gas piping specialties to include in emergency, operation, and maintenance manuals.

1.07 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.08 QUALITY ASSURANCE

- A. Installer Qualifications:

1. Medical Gas Piping Systems for Healthcare Facilities: According to ASSE Standard #6010 for medical-gas-system installers.
 2. Bulk Medical Gas Systems for Healthcare Facilities: According to ASSE Standard #6015 for bulk-medical-gas-system installers.
 3. 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 medical gas 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

2.01 SYSTEM DESCRIPTION

- A. Medical oxygen operating at 50 to 55 psig (345 to 380 kPa).

2.02 PIPES, TUBES, AND FITTINGS

- A. Comply with NFPA 99 for medical gas piping materials.
- B. Copper Medical Gas Tube: ASTM B 819, Type K 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 blue for Type L tube.
- C. 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.
- D. Copper Unions: ASME B16.22 or MSS SP-123, wrought-copper or cast-copper alloy.
- E. 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.

2.03 JOINING MATERIALS

- A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.
- B. Threaded-Joint Tape: PTFE.

2.04 VALVES

- A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
- B. Zone-Valve Box Assemblies: Box with medical gas valves, tube extensions, and gages.
1. Zone-Valve Boxes:
 - a. Steel Box with Aluminum Cover:
 - 1) Acceptable manufacturers: Beacon Madaes, Amico and Chemetron.
 - b. Steel Box with Stainless-Steel Cover:
 - 1) Acceptable manufacturers: Beacon Madaes, Amico and Chemetron.
 - c. Description: Formed steel box with cover, anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.
 - 1) Interior Finish: Factory-applied white enamel.

- 2) Cover Plate: Aluminum or stainless-steel with frangible or removable windows.
 - 3) Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.
- C. 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 type with locking device.
 8. Stem: Blowout proof with PTFE or TFE seal.
 9. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions with pressure gage on one copper-tube extension.
- D. Check Valves:
1. Acceptable manufacturers: Beacon Medaes, Amico and Chemetron.
 2. Description: In-line pattern, bronze.
 3. Pressure Rating: 300 psig (2070 kPa) minimum.
 4. Operation: Spring loaded.
 5. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- E. Emergency Oxygen Connections: Low-pressure oxygen inlet assembly for connection to building oxygen piping systems.
1. Acceptable manufacturers: Beacon Madaes, Amico and Chemetron.
 2. Enclosure: Weatherproof hinged locking cover with caption similar to "Emergency Low-Pressure Gaseous Oxygen Inlet."
 3. Inlet: Manufacturer-installed, NPS 1 or NPS 1-1/4 (DN 25 or DN 32), ASTM B 819, copper tubing with NPS 1 (DN 25) minimum ball valve.
 4. Safety Valve: Bronze-body pressure relief valve set at 75 or 80 psig (520 or 550 kPa).
 5. Instrumentation: Pressure gage.
- F. Safety Valves:
1. Bronze body.
 2. ASME-construction, poppet, pressure-relief type.
 3. Settings to match system requirements.

2.05 MEDICAL GAS SERVICE CONNECTIONS

- A. Acceptable manufacturers: Beacon Medaes, Amico and Chemetron.
- B. General Requirements for Medical Gas Service Connections:
1. Suitable for specific medical gas pressure and suction service listed.
 2. Include roughing-in assemblies, finishing assemblies, and cover plates.
 3. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate.
 4. Recessed-type units made for concealed piping unless otherwise indicated.
- C. Roughing-in Assembly:
1. Steel outlet box for recessed mounting and concealed piping.
 2. Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed. Suction inlets to be without secondary valve.
 3. Double seals that will prevent gas leakage.
 4. ASTM B 819, NPS 3/8 (DN 10) copper outlet tube brazed to valve with service marking and tube-end dust cap.

- D. Finishing Assembly:
 - 1. Brass housing with primary check valve.
 - 2. Double seals that will prevent gas leakage.
 - 3. Cover plate with gas-service label.
- E. Quick-Coupler Pressure Service Connections: Outlets for oxygen with non-interchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.
- F. Quick-Coupler Pressure Service Connections: Outlets for medical air and instrument air with non-interchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.
- G. Quick-Coupler Suction Service Connections: Inlets for medical vacuum and WAGD with non-interchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.
- H. D.I.S.S. Pressure Service Connections: Outlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.
 - 1. Medical Oxygen: D.I.S.S. No. 1240.
- I. D.I.S.S. Pressure Service Connections: Outlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.
 - 1. Medical Air: D.I.S.S. No. 1160.
 - 2. Instrument Air: D.I.S.S. No. 1160.
- J. D.I.S.S. Suction Service Connections: Inlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.
 - 1. Medical Vacuum: D.I.S.S. No. 1220.
 - 2. WAGD: D.I.S.S. No. 2220.
- K. Cover Plates: One piece, aluminum, or stainless-steel and permanent, color-coded, identifying label matching corresponding service.

PART 3 - EXECUTION

3.01 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.

3.02 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of gas piping. Indicated locations and arrangements were 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. Comply with NFPA 99 for installation of medical gas 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 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.
- H. Install piping to permit valve servicing.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and for branch connections.
- K. Install medical gas piping to medical gas service connections specified in this Section, to medical gas service connections in equipment specified in this Section, and to equipment specified in other Sections requiring medical gas service.
- L. Install exterior, buried medical gas piping in protective conduit fabricated with PVC pipe and fittings. Do not extend conduit through foundation wall.
- M. Piping Restraint Installation: Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 20 0800 "Seismic Protection."
- N. Install medical gas service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
- O. Connect gas piping to gas sources and to gas outlets and equipment requiring gas service.
- P. Install unions in copper tubing adjacent to each valve and at final connection to each specialty and piece of equipment.
- Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 0500 "Basic Plumbing Materials and Methods."
- R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 0500 "Basic Plumbing Materials and Methods."
- S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 0500 "Basic Plumbing Materials and Methods."

3.03 VALVE INSTALLATION

- A. Install shutoff valve at each connection to gas laboratory and healthcare equipment and specialties.
- B. Install check valves to maintain correct direction of gas flow from laboratory and healthcare gas supplies.

- C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
- D. Install zone valves and gages in valve boxes. Arrange valves so largest valve is lowest. Rotate valves to angle that prevents closure of cover when valve is in closed position.

3.04 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," "Braze Joints" chapter. Continuously purge joint with oil-free, dry nitrogen during brazing.

3.05 GAS SERVICE COMPONENT INSTALLATION

- A. Assemble patient-service console with service connections. Install with supplies concealed in walls. Attach console box or mounting bracket to substrate.

3.06 IDENTIFICATION

- A. Install identifying labels and devices for specialty gas piping, valves, and specialties. Comply with requirements in Section 22 0500 "Basic Plumbing Materials and Methods".
- B. Install identifying labels and devices for healthcare medical gas piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
 - 1. Carbon Dioxide: Black or white letters on gray background.
 - 2. Oxygen: White letters on green background or green letters on white background.

3.07 FIELD QUALITY CONTROL FOR HEALTHCARE FACILITY MEDICAL GAS

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
 - 1. Medical Gas Piping Testing Coordination: Perform tests, inspections, verifications, and certification of medical gas piping systems concurrently with tests, inspections, and certification of medical compressed-air piping and medical vacuum piping systems.
 - 2. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
 - a. Initial blowdown.
 - b. Initial pressure test.
 - c. Cross-connection test.
 - d. Piping purge test.
 - e. Standing pressure test for positive-pressure medical gas piping.
 - f. Standing pressure test for vacuum systems.
 - g. Repair leaks and retest until no leaks exist.
 - 3. System Verification: Perform the following tests and inspections according to NFPA 99, ASSE Standard #6020, and ASSE Standard #6030:
 - a. Standing pressure test.
 - b. Individual-pressurization or pressure-differential cross-connection test.
 - c. Valve test.
 - d. Master and area alarm tests.
 - e. Piping purge test.
 - f. Piping particulate test.
 - g. Piping purity test.
 - h. Final tie-in test.
 - i. Operational pressure test.
 - j. Medical gas concentration test.
 - k. Medical air purity test.

- l. Verify correct labeling of equipment and components.
 - m. Verify medical gas supply sources.
 - 4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
 - a. Inspections performed.
 - b. Procedures, materials, and gases used.
 - c. Test methods used.
 - d. Results of tests.
- C. Remove and replace components that do not pass tests and inspections and retest as specified above.
- D. Prepare test and inspection reports.

3.08 FIELD QUALITY CONTROL FOR LABORATORY FACILITY SPECIALTY GAS

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
 - 1. Piping Leak Tests for Specialty Gas Piping: Test new and modified parts of existing piping. Cap and fill specialty gas 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 specialty gas regulators for proper operation.
- C. Remove and replace components that do not pass tests and inspections and retest as specified above.
- D. Prepare test and inspection reports.

3.09 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.

3.10 DEMONSTRATION

- A. Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain bulk gas storage tanks.

3.11 PIPING SCHEDULE

- A. Medical Gas Piping except Medical Nitrogen Piping NPS 3 (DN 80) and smaller Operating at 185 psig (1275 kPa) or less: Type L, copper tube; wrought-copper fittings; and brazed joints.

3.12 VALVE SCHEDULE

- A. Shutoff Valves: Oxygen cleaned and bagged ball valve with manufacturer-installed ASTM B 819, copper-tube extensions.
- B. Zone Valves: Oxygen cleaned and bagged ball valve with manufacturer-installed ASTM B 819, copper-tube extensions with pressure gage on one copper-tube extension.

END OF SECTION

THISPAGELEFT INTENTIONALLY BLANK

SECTION 23 0100
BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.01 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. Record documents.
 - 4. Maintenance manuals.

1.02 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.

1.03 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.

1.04 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.

1.05 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.

1.06 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.

1.07 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.

1.08 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

3.01 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

1.01 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 flanges.
 4. Flexible pipe connectors.
 5. Modular sleeve seals.
 6. Pipe sleeves.
 7. Escutcheons.
 8. Penetration firestopping of fire-resistance-rated assemblies and/or smoke barriers by mechanical piping, conduit, or ductwork
 9. Labeling and identifying mechanical systems and equipment.
 10. Non-shrink grout for equipment installations.
 11. Painting and finishing of mechanical work.
 12. Concrete base construction requirements.
 13. Coordination with Structural work.
 14. Field-fabricated equipment supports.
 15. Selective Demolition.
 16. Cutting and patching.

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 0548 "Vibration and Seismic Controls for HVAC," and Section 23 0100 "Basic Mechanical Requirements" apply 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.

1.03 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 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.

1.04 SUBMITTALS

- A. Product Data: For dielectric flanges or nipples, 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.

1.05 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.

1.06 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.

1.07 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. 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. Coordinate construction scope with phasing plan provided by architect.

PART 2 - PRODUCTS

2.01 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. 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.
- 4. Dielectric Waterway:
 - a. Clearflow
 - b. Victaulic, 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.

2.02 PIPE AND PIPE FITTINGS

- A. Refer to individual Division 23 piping Sections for pipe and fitting materials and joining methods.

2.03 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.

2.04 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 ¾-inch and larger; steel pipe flange shall be threaded-on in sizes ¾-inch to 2-inch. Other flanges and flange bolting kits are specified in "Joining Materials" subsection above.
- B. **DIELECTRIC NIPPLES ARE NOT ALLOWED. REFER TO 232113 HYDRONIC PIPING FOR ALLOWED SYSTEMS.**

2.05 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.

2.06 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.

2.07 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 or Nitrile rubber, 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).

2.08 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.

2.09 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 sub core, 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 / Smoke / Fire-Smoke Dampers. Install at location unobstructed to view in rooms. Use numbers, lettering and wording as indicated on Fire / Smoke / Fire-Smoke Damper sheets of Construction Documents.
- G. Valve Tags:
 - 1. Description: Photo-anodized barcode tags with ¼-inch (6-mm) letters and numbers. Include 5/32-inch (4-mm) hole for fastener.
 - 2. Material: 0.032-inch (0.8-mm) thick anodized aluminum.
 - 3. Color: Silver background with black characters.
 - 4. 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.

5. Valve Tag Fasteners: Brass, wire-link chain or stainless-steel beaded chain.
- H. 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."

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

3.01 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.

3.02 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."

3.03 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 pipefittings 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.

3.04 PIPE-PENETRATION INSTALLATION REQUIREMENTS

- A. Except as noted otherwise, install escutcheons for both insulated and bare piping in the following cases:
1. New piping 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.

3.05 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 chiller.
 - 2. At each connection to a packaged computer-room air-conditioning unit.
 - 3. Where indicated elsewhere in these specifications.
 - 4. Where detailed on the Drawings.
- F. Support for Suspended Equipment: As specified in Division 23 Section "Hangers and Supports."

3.06 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. 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.
- D. 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).
- 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 HVAC terminal devices and similar roughing-in connections of end-use fixtures and units.

3.07 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.

3.08 CONCRETE BASES

- A. Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to Division 20 Section "Seismic Protection."
- B. Construct concrete bases of dimensions indicated, but not less than 6 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.

3.09 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.

3.10 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

THISPAGELEFT INTENTIONALLY BLANK

SECTION 23 0513

MOTORS

PART 1 - GENERAL

1.01 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.

1.02 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 0548 "Vibration and Seismic Controls for HVAC," 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.

1.03 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. TEAO: Totally enclosed, air-over.
- E. TEFC: Totally enclosed, fan cooled.

1.04 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.

1.05 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.

1.06 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

2.01 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.

2.02 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.

2.03 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.

2.04 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.

2.05 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

3.01 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

SECTION 23 0519
METERS AND GAGES

PART 1 - GENERAL

1.01 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.
 - 5. Test plugs.

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 0548 "Vibration and Seismic Controls for HVAC," 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 "HVAC Instrumentation and Controls" 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 "HVAC Instrumentation and Controls."

1.03 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.

1.04 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

2.01 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. Test Plugs:
 - a. Flow Design, Inc.
 - b. Miljoco Corporation.
 - c. Peterson Equipment Co., Inc. ("Pete's Plugs")
 - d. Sisco Manufacturing Company, Inc.
 - e. H.O. Trerice Co.
 - f. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
 - g. Weiss Instruments, Inc.

2.02 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.

2.03 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.

2.04 TEST PLUGS

- A. Description: Test-station fitting made for insertion into piping tee fitting.
1. Body: Brass or stainless-steel with core inserts. Include extended stem on units to be installed in insulated piping, with length as required to extend beyond insulation
 2. Test-Plug Cap: Gasketed and threaded cap, with retention chain.
 3. Thread Size: NPS ½ (DN 15), ASME B1.20.1 pipe thread.
 4. Minimum Pressure and Temperature Rating: 500 psig at 200°F (3450 kPa at 93°C).
- B. Core Inserts: Two (2) EPDM self-sealing rubber valve types, suitable for inserting a 1/8-inch outside-diameter probe from a dial thermometer or pressure gage.
- C. Furnish one test-plug kit(s) containing two thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
1. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- (25- to 51-mm-) diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125°F (minus 4 to plus 52°C).
 2. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- (25- to 51-mm-) diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220°F (minus 18 to plus 104°C).
 3. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch- (51- to 76-mm-) diameter dial and probe. Dial range shall be at least 0 to 200 psig (0 to 1380 kPa).
 4. Carrying Case: Metal or plastic, with formed instrument padding.

PART 3 - EXECUTION

3.01 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 test plugs in piping tees where indicated, located on pipe at most readable position. Secure cap.
 - 1. Inlet and outlet of each hydronic boiler.
 - 2. Two inlets and two outlets of each chiller.
 - 3. Inlet and outlet of each hydronic coil in air-handling units.
 - 4. Two inlets and two outlets of each hydronic heat exchanger.
 - 5. Inlet and outlet of each thermal-storage tank.
 - 6. Outside-, return-, supply-, and mixed-air ducts.
- G. 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.
- H. Install pressure gages in the following locations:
 - 1. Discharge of each pressure-reducing valve.
 - 2. Inlet and outlet of each chiller chilled-water and condenser-water connection.
 - 3. Multiple points at each pump as detailed on Drawings. Pressure gages serving pump differential measurement shall be liquid-filled and shall include snubber.
 - 4. Where indicated on Drawings.
- I. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.
- J. 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

SECTION 23 0523
VALVES

PART 1 - GENERAL

1.01 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. Gate valves.
 - 5. Globe and angle valves.
 - 6. Chainwheel actuators.

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 0548 "Vibration and Seismic Controls for HVAC," 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 "HVAC Instrumentation and Controls" for control valves and actuators.
 - 5. Division 23 piping Sections for specialty valves applicable to those Sections only.
- D. Valves for refrigerant, medical gases, fire protection, and other specialty services are specified in their respective piping Section.

1.03 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.

1.04 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.

1.05 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.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set angle, 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

2.01 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.
- 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.; Apollo Div.
 - 3. Johnson Control Inc.
 - 4. Griswold Co.
 - 5. Nexus
 - 6. Victaulic Co.
 - 7. Standard-Performance Butterfly Valves: Subject to compliance with requirements, provide butterfly valves by one of the following:
 - 8. Any of the manufacturers listed under the "General" subheading above.
 - 9. Bray International, Inc.
 - 10. Crane Co.; Crane Valve Group; Center Line brand.
 - 11. General Signal; DeZurik Unit
 - 12. McWane, Inc.; Kennedy Div.
 - 13. Metraflex Co.
 - 14. Grinnell
 - 15. High-Performance Butterfly Valves for Steam and Condensate Service: Subject to compliance with requirements, provide butterfly valves by one of the following:

16. Adams Type MAK
 17. Bray International, Inc.
 18. Jamesbury, Inc
 19. Keystone; a brand of Pentair plc.
 20. Tomoe Tritec.
- C. Wafer and Lift-Disc 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.
- D. High Performance Gate Valves (NPS 2 (DN50) and smaller) one of the following:
1. Hancock 950 S (screwed); Hancock 950 W (socket weld)
 2. Vogt 1211 (screwed); Vogt SW 1211 (socket weld)
- E. High Performance Gate Valves (NPS 2½ (DN65) and larger) one of the following:
1. Crane No. 47XUF
 2. Stockham 15-OF-U
 3. Kitz K150 SCL
- F. High Performance Globe Valves (NPS 2 (DN50) and smaller) one of the following:
1. Hancock 5500S (screwed); Hancock 5500 W (socket weld)
 2. Vogt 12141 (screwed); Vogt SW 12141 (socket weld)

2.02 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.

2.03 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, three-piece construction.
 5. Ball: Type 316 stainless steel, full port for NPS 1 (DN 25) and smaller, regular port otherwise.
 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. Sheild: Plastic Sleeve
 - f. Lock Washer: Stainless Steel
 - g. Stop Plate & Screws: Stainless Steel
 - h. Memory Stop Assembly: Stainless Steel.

2.04 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 and grooved 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.

2.05 HIGH-PERFORMANCE BUTTERFLY VALVES

- A. Application: Rated for steam and condensate service, 2½ inches and larger.
- B. General: Valve shall conform to MSS SP-68.
- C. Minimum CWP Rating: Class 300 as defined in Part 1.
- D. Body and bonnet: ASTM A 216 cast-steel body, extended neck.
- E. Seat: Reinforced PTFE or metal as required to meet specified Class rating.
- F. Stem and Stem Hardware: Stainless steel, offset from seat plane.
- G. Disc: Carbon Steel, with ASTM A167 seal.
- H. End Connections: Lug and flanged bodies are acceptable; wafer bodies are not acceptable.
- I. 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.
- J. Operator: Gear operator with position indicator and handwheel; chainwheel if installed 96 inches (2400 mm) or higher above finished floor elevation.

2.06 STAINLESS STEEL BUTTERFLY VALVES (for clean steam)

- A. Body and bonnet: Stainless steel body and trim, lugged style, stainless steel solid wedge, fluorocarbon polymer seats, Class 150.
- B. Disc, Stem and Stem Hardware: Stainless steel, offset from seat plane.
- C. 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.
- D. Operator: Gear operator with position indicator and handwheel; chainwheel if installed 96 inches (2400 mm) or higher above finished floor elevation.

2.07 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.
- 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.

2.08 GATE VALVES

- A. NPS 2 (DN50) and smaller: Valve shall conform to MSS SP-80.
 - 1. Minimum pressure rating: Class 150.
 - 2. Body: ASTM B62 bronze body and bronze-fitted.
 - 3. Bonnet: ASTM B62 bronze union-ring.
 - 4. Disc: ASTM B62 bronze solid wedge.
 - 5. Stem: Bronze alloy rising-type.
 - 6. Packing: Non-asbestos packing with bronze packing nut and gland.
 - 7. Ends: Threaded.
 - 8. Handle: Ferrous-alloy handwheel.
- B. NPS 2½ (DN65) and larger: Valve shall conform to MSS SP-70, 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: ASTM A126 Cl. B cast-iron or bronze-alloy, solid wedge.
 - 5. Stem: Brass alloy rising-type with outside screw and yoke.
 - 6. Packing: Non-asbestos packing with 2-piece packing gland assembly.
 - 7. Ends: Flanged.
 - 8. Handle: Cast-iron handwheel.

- C. High-Performance Valves, NPS 2½ (DN65) and larger for steam and condensate return applications: Valve shall conform to MSS SP-55.
 - 1. Minimum pressure rating: Class 300.
 - 2. Body: ASTM A 216 carbon steel body.
 - 3. Bonnet: ASTM A 216 carbon steel body.
 - 4. Disc: ASTM A 216 carbon steel, solid wedge.
 - 5. Stem: ASTM A 182 rising-type with outside screw and yoke.
 - 6. Packing: Non-asbestos packing with 2-piece packing gland assembly.
 - 7. Ends: Flanged.
 - 8. Handle: Cast-iron handwheel.
- D. Stainless Steel Gate Valves 2-inch NPS and Smaller: Stainless steel body, flanged or socket-welded ends, stainless steel solid wedge, stellite seats, rising stem, union bonnet, malleable iron handwheel, impregnated Teflon packing, Class 150.
- E. Stainless Steel Gate Valves 2½-inch NPS and Larger: Stainless steel body, flanged ends, stainless steel solid wedge, stellite seats, impregnated Teflon packing, Class 150.
 - 1. Stem: ASTM A182 rising-type with outside screw and yoke.**
 - 2. Ends: Stainless-steel flanges.**
 - 3. Handle: Cast-iron handwheel.**

2.09 GLOBE VALVES

- A. Flow Pattern: Straight or angle pattern at Contractor's option, to accommodate piping layout and route.
- B. NPS 2 (DN50) and smaller: Valve shall conform to MSS SP-80.
 - 1. Minimum pressure rating: Class 150.
 - 2. Body: ASTM B62 bronze body and bronze-fitted.
 - 3. Bonnet: ASTM B62 bronze union-ring.
 - 4. Disc: Nonmetallic.
 - 5. Stem: Bronze alloy rising-type.
 - 6. Packing: Non-asbestos packing with bronze packing nut and gland.
 - 7. Ends: Threaded.
 - 8. Handle: Ferrous-alloy handwheel.
- C. NPS 2½ (DN65) and larger: Valve shall conform to MSS SP-85.
 - 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: Renewable bronze-alloy seats and disc.
 - 5. Stem: Brass alloy rising-type with outside screw and yoke.
 - 6. Packing: Non-asbestos packing with cast-iron follower.
 - 7. Ends: Flanged.
 - 8. Handle: Cast-iron handwheel.
- D. High-Performance Valves, NPS 2½ (DN65) and larger for steam and condensate return applications: Valve shall conform to MSS SP-55.
 - 1. Minimum pressure rating: Class 300.
 - 2. Body: ASTM A 216 carbon steel body.
 - 3. Bonnet: ASTM A 216 carbon steel body.
 - 4. Disc: ASTM A 182 disc and ASTM A 105 seat ring.
 - 5. Stem: ASTM A 182 rising-type with outside screw and yoke.
 - 6. Packing: Non-asbestos packing with 2-piece packing gland assembly.
 - 7. Ends: Flanged.
 - 8. Handle: Cast-iron handwheel.

PART 3 - EXECUTION

3.01 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.

3.02 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.

3.03 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.

3.04 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.

3.05 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.
- C. Steam and Steam Condensate 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 gate valves.
 2. For shutoff duty, NPS 2½ (DN 65) and larger, use high-performance gate valves or high-performance butterfly valves.
 3. For throttling duty, NPS 2 (DN 50) and smaller, use globe valves.
 4. For throttling duty, NPS 2½ (DN 65) and larger, use high-performance globe valves.
 5. For one-way flow control and for pump discharge protection, use swing check valves.

END OF SECTION

**SECTION 23 0529
HANGERS AND SUPPORTS**

PART 1 - GENERAL

1.01 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.

1.02 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 0548 "Vibration and Seismic Controls for HVAC," 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 "Vibration and Seismic Controls for HVAC" for seismic restraint requirements.
 - 3. Division 23 Section "Pipe Expansion Fittings" for pipe guides and anchors.
 - 4. Division 23 Section "Mechanical Vibration Isolation" for vibration isolation devices.
 - 5. Division 23 Section "Metal Ducts" for duct hangers and supports.

1.03 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*.

1.04 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.
- F. All mechanical equipment shall be anchored or braced to meet the horizontal and vertical forces/displacements prescribed in the ASCE/SEI 7.
 - 1. The attachment of the following items shall be designed to resist the forces as prescribed above, but need not be detailed on the plans:
 - a. Equipment weighing less than 400 pounds supported directly on the floor or roof.
 - b. Temporary or movable equipment.
 - c. Equipment weighing less than 20 pounds supported by vibration isolators.
 - d. Equipment weighing less than 20 pounds suspended from a roof or floor or hung from a wall.

1.05 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).

1.06 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

2.01 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.

2.02 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.

2.03 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 inturned 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

2.04 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.

2.05 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.

2.06 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.

2.07 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, counterflashing 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 prefabricated 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.

2.08 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

3.01 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.

3.02 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).
- C. Flanged, Threaded, or Welded Steel Piping for Steam and Compressed Air 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).
- 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. Fiberglass, 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).
 7. NPS 3 (DN 80): Maximum span, 4 feet (1.2 m); minimum rod size, 1/2-inch (13 mm).
 8. NPS 4 (DN 100): Maximum span, 4 feet (1.2 m); minimum rod size, 5/8-inch (16 mm).
 9. NPS 6 (DN 150): Maximum span, 4 feet (1.2 m); minimum rod size, 3/4-inch (19 mm).
 10. NPS 8 (DN 200): Maximum span, 4 feet (1.2 m); minimum rod size, 7/8-inch (22 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.

3.03 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.

3.04 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.
3. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.05 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.

3.06 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.

3.07 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).

3.08 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

SECTION 23 0548
VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Elastomeric isolation pads.
 - 2. Restrained elastomeric isolation mounts.
 - 3. Restrained-spring isolators.
 - 4. Housed-restrained-spring isolators.
 - 5. Pipe-riser resilient supports.
 - 6. Resilient pipe guides.
 - 7. Elastomeric hangers.
 - 8. Spring hangers.
 - 9. Restraint channel bracings.
 - 10. Restraint cables.
 - 11. Seismic-restraint accessories.
 - 12. Mechanical anchor bolts.
 - 13. Adhesive anchor bolts.
 - 14. Vibration isolation equipment bases.
 - 15. Restrained isolation roof-curb rails.

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 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.
 - 4. Other Division 21 through 28 Sections for equipment that is to be mounted on vibration isolation.

1.03 DEFINITIONS

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include itemized list by equipment item indicating vibration isolation selections including manufacturer and model number. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-restraint component required.
 - a. See Evaluations for a discussion on seismic-restraint capacities and rating services.
 - b. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.

- c. Annotate to indicate application of each product submitted and compliance with requirements.
 3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer who is legally qualified to practice in the jurisdiction where the Project is located and who is experienced in providing engineering services of the kind indicated. Include the following:
 1. Design calculations and details for selecting vibration isolators, seismic restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data.
 2. Design Calculations: Calculate static and dynamic loading due to equipment weight, operation, and seismic forces required to select vibration isolators and 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. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
 4. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
 5. 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, spacings and all required bracing. 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 agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
- B. Manufacturer Seismic Qualification Certification: Submit certification that all specified equipment will withstand seismic forces identified in this section.

1.05 INFORMATIONAL SUBMITTALS

- A. Vibration isolation hardware must not be concealed until approval is obtained from the owner's field representative.
- B. Verify specified clearances; plumb installation of hanger rods and lack of interference (e.g., no contact is permitted with gypsum board, framing, ceiling wires, conduit, ducts, and piping).
- C. Verify proper vibration isolator loading and deflection.
- D. Vibration isolation supplier to generate punch list report for Construction Administrator's review.

1.06 QUALITY ASSURANCE

- A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

- B. Single-Source: All vibration isolation devices shall be the product of a single manufacturer.
- C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are unavailable, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

1.07 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

2.01 GENERAL

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers listed in this Section with regard to seismic protection. Single-source responsibility is required; the contractor shall furnish products under this section for seismic and vibration by the same manufacturer.
- 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.

2.02 PERFORMANCE REQUIREMENTS

- 1. Retain "Wind-Restraint Loading" Paragraph below for outdoor equipment.
- A. Wind-Restraint Loading:
 - 1. Obtain values for items in subparagraphs below from Project structural engineer or from ASCE/SEI 7.
 - 2. Wind load shall be determined per ASCE 7, basic wind speed equal to 115mph, exposure category C.
 - 3. Minimum 10 lb/sq. ft. (48.8 kg/sq. m) multiplied by maximum area of HVAC component projected on vertical plane normal to wind direction, and 45 degrees either side of normal.
- B. Seismic-Restraint Loading:
 - 1. Obtain values for items in subparagraphs below from Project structural engineer or from ASCE/SEI 7. If the code at Project site is other than the IBC or NFPA 5000, revise parameters to comply with applicable code.
 - 2. Seismic forces shall be determined by ASCE7
 - a. Site Class as Defined in the IBC: C.

3. In "Assigned Seismic Use Group or Building Category as Defined in the IBC" Subparagraph below, retain Seismic Use Group or Building Category for Project structure from three classifications defined in the IBC.
4. Assigned Seismic Risk Category: III.
 - a. Component Importance Factor: refer to structural drawings
5. Design Spectral Response Acceleration at Short Periods (0.2 Second): refer to structural drawings.
6. Design Spectral Response Acceleration at 1.0-Second Period: refer to structural drawings.
7. Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

2.03 Materials

- A. Isolators shall be selected by the supplier based on the static and dynamic loads supported. Dynamic loads include those due to: wind, fluid flow, thrust, and rotational inertia. Select each isolator independently for the load distribution on the equipment base, duct, or pipe support.
- B. Vibration isolators shall have either known height without a load, or other markings so that after adjustment, when fully loaded, the deflection can be verified.
- C. All static deflections are nominal and actual installed deflections are to be $\pm 15\%$ of the specified value.
- D. All spring isolators shall be laterally stable and have leveling bolts. Spring isolators shall have a minimum additional "travel" to full compression of half the rated deflection. The ratio of lateral to vertical stiffness shall be 0.9 minimum and 1.5 maximum.
- E. Provide all floor-mounted spring isolators with mounting base plates that provide for bolting to the floor and incorporate 3/4-inch-thick Class "E" neoprene bearing pads. Where neoprene bearing pads provided with spring isolators are less than 3/4-inch-thick, provide additional resilient pad(s) to achieve an overall thickness of 3/4-inch, minimum.
- F. Spring isolation hangers shall incorporate a resilient neoprene element of 1/4-inch minimum thickness to prevent solid contact between the spring and isolator housing.
- G. Equipment requires a minimum of four isolators, one at each corner.
- H. Confirm suitability of vibration isolation system with equipment manufacturers wherever necessary.
- I. Equipment support frames and bases shall be selected by the supplier in order to use the specified isolators.
- J. All vibration isolators installed outdoors shall use EPDM or equivalent elastomeric elements in place of neoprene. All metal parts are to be factory primed and painted.
- K. All neoprene material to have anti-ozone and anti-oxidant additives.
- L. Snubbers must not limit the vibration isolation capability during normal operation. Where steel limit stops are used, provide 1/4-inch-thick neoprene to prevent metal-to-metal contact.
- M. Where indicated, slack cable restraints are to be installed at each isolator. Size slack cables and anchors to support entire equipment load. Isolators located at the corners of equipment require two slack cables perpendicular to one another in the horizontal plane. The allowable equipment movement must be restricted to prevent springs from disengaging their mountings.

2.04 MANUFACTURER

- 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. Kinetics Noise Control, Inc.
 2. Mason Industries, Inc.
 3. Vibration Mountings & Controls, Inc. (Vibrex)

2.05 VIBRATION ISOLATORS

- A. 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.
- B. 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.
- C. 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.
- D. 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.
- E. 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.
- F. 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.

2.06 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.

2.07 SEISMIC-RESTRAINT DEVICES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide M.W. Saussé or a comparable product by one of the following:
 1. Amber/Booth Company, Inc.
 2. Cooper B-Line, Inc.; a division of Cooper Industries
 3. Hilti, Inc.
 4. Kinetics Noise Control
 5. Mason Industries
 6. Unistrut; Tyco International, Ltd.
- B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of ICC-ES.
- C. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- D. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.
- E. Channel Brace: 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 and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.
- F. 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.
- G. Restraint Cables: ASTM A603 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.
- H. 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.
- I. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
- J. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- K. Type I, Equipment Not Vibration Isolated
 1. Attach to the structure in accordance with the requirements of IBC
- L. Type II, Vibration Isolated Equipment
 1. Mount all vibration isolated equipment on rigid steel frames as described in the vibration control specifications unless the equipment manufacturer certifies direct attachment capability.

2. Each isolated frame shall have a minimum of four all directional seismic snubbers located as close to the vibration isolators as possible.
 3. The snubber shall consist of interlocking steel members restrained by snubbing material made of bridge bearing neoprene.
 4. The snubbers shall contain an elastomeric neoprene one-piece bushing that is replaceable and a minimum of 1/4 inch thick. Snubbers shall be manufactured with an air gap between hard and resilient material of not less than 1/8 inch or more than 1/4 inch. The neoprene bushing shall be capable of rotation to verify that no short circuiting of the vibration isolator exists. Shim snubbers as required to maintain clearances.
 5. The snubber end cap shall be removable for inspection of snubber internal clearances.
- M. Type III, Seismic Restraint of Suspended Piping
1. Support all piping and ductwork systems per SMACNA "Guidelines for Seismic Restraints of Mechanical Systems and Plumbing Piping Systems" and 2010 California Building Code.
 2. Provide restraints for all trapeze mounted piping where the total supported weight is greater than or equal to a 2-1/2-inch pipe, except in equipment rooms where all trapeze mounted piping weight is greater or equal to 1-1/4-inch pipe.
 3. Provide restraints for all piping 1-1/4 inch and larger located in boiler rooms, mechanical equipment rooms and refrigeration machinery rooms.
 4. Provide restraints for all fuel gas and oil piping, medical gas piping and compressed air piping 1 inch and larger.
 5. Cable shall be installed with sufficient slack to avoid short circuiting the vibration isolation.
- N. Type IV, Suspended Equipment
1. Utilize a slack cable restraint system.
 2. Cables shall be installed with sufficient slack to avoid short circuiting the vibration isolation.

2.08 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 E488.

2.09 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 E488.

2.10 RESTRAINED VIBRATION ISOLATION SEISMIC ROOF-CURB RAILS

- A. Description (Schedule Designation Type D): Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand 125-mph (56-m/s) wind impinging laterally against side of equipment. Model SRSC by Mason Industries, Inc.
- B. Lower Support Assembly: Sheet-metal "Z" section containing adjustable and removable steel springs that support upper floating frame. Upper frame shall provide continuous support for equipment and shall be captive to resiliently resist wind and seismic forces. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials and shall be insulated with a minimum of 2-inches (50 mm) of rigid, glass-fiber insulation on inside of assembly.
- C. Overall Height: Minimum 18-inches (450 mm).
- D. Restrained Spring Isolators: Schedule Designation Type 4 as specified above, plus shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations.

Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.

- E. Snubber Bushings: All-directional, elastomeric snubber bushings at least ¼-inch (6 mm) thick.
- F. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counter flashed over roof materials.

2.11 FLEXIBLE CONNECTORS:

- A. Flexible connections for the air distribution system shall be fabricated from glass fabric coated with neoprene or other approved material and weighing a minimum 30 oz. per square yard. The minimum clear dimension of the flexible connectors, not including the clamping section, shall be 6 inches.
- B. Flexible connectors for HVAC piping systems shall be rated for operating pressure, temperature, and fluid type. At water piping, provide:
 - 1. Inside diameter 2-1/2 inches and larger: Mason Type Safeflex SFDEJ or equal.
 - 2. Inside diameter 3/4 inch to 2 inches: Mason Type MFTFU or equal.
 - 3. Inside diameter 1/2 inch: Mason Type RMM or equal.

2.12 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 and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic and wind control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated on Seismic Shop Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.

3.03 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Install vibration and seismic 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.
- B. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork as specified in Division 03.
 - C. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
 - D. Do not use vibration isolation components to straighten or connect misaligned sections of piping or ductwork.
 - E. Comply with requirements in Section 07 72 00 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
 - F. Equipment Restraints:
 - 1. Indicate type and quantity of snubbers described in first subparagraph below on Drawings or in the HVAC Vibration-Control and Seismic-Restraint Device Schedule on Drawings.
 - 2. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
 - 3. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 - 4. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
 - G. Piping Restraints:
 - 1. Comply with requirements in MSS SP-127.
 - 2. Space lateral supports a maximum of 40 feet (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.
 - 3. Brace a change of direction longer than 12 feet (3.7 m).
 - H. Install slack cables at all vibration isolated equipment that is to be restrained using steel braided cables appropriately sized and attached for the loads.
 - I. Install cables so they do not bend across edges of adjacent equipment or building structure.
 - J. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
 - K. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
 - L. 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.
 - M. 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.
 - N. 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.
- O. Install vibration isolation components in full accordance with the manufacturer's instructions.
 - P. Provide a minimum of one-inch clearance between the building structure and vibration isolated supports, ducts, pipes, and equipment.
 - Q. Provide 2-inch minimum clearance under vibration-isolated equipment and the top of the housekeeping pad and/or steel equipment support frames.
 - R. Subsequent to proper alignment, fasten all vibration isolators to the structure. Use bolts where holes are provided in the mounting flange; otherwise, adhere using structural adhesive. Where mounting flanges are steel, use neoprene grommets and washers to isolate anchor bolts from base plates.
 - S. Align spring isolation hanger rods to clear the hanger box under all operating conditions.
 - T. Any bracing or supports for mechanical ductwork, piping, and equipment shall not bridge or reduce the effectiveness of vibration isolators.
 - U. Install flexible connectors at all connections to vibration-isolated equipment.
 - V. Level vibration isolated equipment under rated design operating conditions while maintaining the isolation criteria. Isolators shall be plumb and aligned during operation.

3.04 PIPING ISOLATION

- A. Vibration isolate all pipes in sound-rated construction except vents, gas, and sprinkler lines. Do not allow piping, plumbing, or vent stacks to contact gypsum board.
- B. Do not suspend plumbing or piping from ducts, conduits, or related supports.
- C. Isolate pipes 3-inch diameter and greater attached to the inlet and discharge of prime movers and pressure-reducing valves using spring isolators selected to provide one-inch static deflection for the first six points of support.
- D. Isolate the remainder of pipes 3-inch diameter and greater using elastomeric hangers or mounts selected to provide a static deflection of 0.2 inches. Use elastomeric isolation pads under pipe elbows supported from the floor.
- E. Pipes less than 3 inches diameter attached to primer movers and pressure-reducing valves are to be isolated for a minimum of 25 feet from the inlet and discharge. Use elastomeric hangers or mounts selected to provide a static deflection of 0.2 inches. Use elastomeric pads under pipe elbows supported from the floor. Where these pipes have 3/4-inch-thick or greater resilient thermal insulation between the pipe and the pipe hanger, vibration isolators are not required.
- F. HVAC piping and domestic water in sound-rated construction are to be isolated using elastomeric attachments as appropriate.
- G. Isolate hydronic piping in walls and ceilings using elastomeric attachments as appropriate.
- H. Waste pipes in sound-rated spaces are to be attached using elastomeric attachments in horizontal isolator runs and in vertical runs elastomeric isolation pads underneath the supporting clamps. Use elastomeric isolation pads under pipe elbows supported from the floor.
- I. All other individual pipes in sound-rated construction shall be isolated using elastomeric attachments. For pipes less than 3 inches in diameter with resilient thermal insulation between the pipe and pipe support, resilient attachments are not required.

- J. All other grouped pipes shall be isolated by using elastomeric hangers supporting trapeze hangers and selected to provide a static deflection of 0.2 inches. Grouped floor-supported pipes shall be isolated using elastomeric selected to provide a static deflection of 0.15 inches. Where vertical orientation of the isolator attachment base is required, use an elastomeric mount.

3.05 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post-connection 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.
 - 6. Measure isolator restraint clearance.
 - 7. Measure isolator deflection.
 - 8. Verify snubber minimum clearances.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.

3.06 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. Adjust active height of spring isolators.
- D. Adjust snubbers according to manufacturer's written recommendations.
- E. Adjust seismic restraints to permit free movement of equipment within normal mode of operation.
- F. Torque anchor bolts according to equipment manufacturer's written recommendations to resist seismic forces.

3.07 VIBRATION ISOLATION EQUIPMENT BASES 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 03 30 53, "Miscellaneous Cast-in-Place Concrete."

3.08 HVAC VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE SCHEDULE

- A. HVAC PIPING VIBRATION ISOLATION SCHEDULE

	Design Deflection	Isolator	Seismic Restraint
		Type	Type
Main Horizontal Runs	N/A	RPS1	III
Suspended within Mechanical Room	1.0"	H3	III
Floor Supported	1.0"	S1	-
Main Vertical Risers	N/A	RPAG1, RPAG2	N/A

1. Use flexible, duct, pipe and conduit at connections to all vibration isolated equipment.
2. Limit fluid velocities in pipes as follows:
 - a. 2" diameter piping and smaller – 4 f.p.s. maximum
 - b. Piping larger than 2" diameter – 6 f.p.s. local to condominiums and guestrooms, 10 f.p.s. maximum elsewhere.

B. HVAC EQUIPMENT VIBRATION ISOLATION SCHEDULE

1. 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*.
2. All 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.
3. Supported Equipment: Chiller (CH-2)
 - b. Equipment Location: 3rd Floor Roof (same level as fourth floor)
 - c. Isolator Type: Type 4 – Restrained Spring Isolator
 - d. Base Type: Type B – Structural Rails
 - e. Minimum Deflection: 1.5" (38.1 mm)
4. Suspended Equipment: Computer Room Unit (CRU-2)
 - f. Equipment Location: 1st Floor MRI Equipment Room - 1237
 - g. Isolator Type: Type 2H or 3H – Elastomeric/Spring Hanger
 - h. Minimum Deflection: 0.75" (19.1 mm)

END OF SECTION

SECTION 23 0594
TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 23 0548 "Vibration and Seismic Controls for HVAC," 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.

1.02 GENERAL

- A. The Owner shall hire the Testing, Adjusting and Balancing services which shall be independent of this contract. This contractor's responsibility is as indicated below.
- B. The installing contractor shall have completed the following work prior to requesting the TAB effort:
 - 1. Cleaned and flushed all piping systems.
 - 2. Leak tested and made tight all piping systems.
 - 3. Filled all piping systems with clean water.
 - 4. Cleaned and leak-tested all ductwork.
 - 5. Serviced and tagged all equipment.
 - 6. Started up and proved all equipment and systems.
 - 7. Made preliminary settings on all controls devices and have all systems operational.
 - 8. Operate all systems successfully for twenty-four hours minimum.
- C. Installing Contractor's Responsibility:
 - 1. The installing contractor shall notify the Owner's Representative fourteen (14) days prior to the scheduled date for balancing the system.
 - 2. The installing contractor shall schedule two (2) week allowance for the testing and balancing firm to complete the testing and balancing work when scheduling completion of all work required of the installing contractor by the contract documents.
 - 3. The installing contractor shall cooperate with the testing and balancing firm and shall make all necessary preparations for the TAB efforts.
 - 4. Lubricate all motors and bearings.
 - 5. Patch insulation using materials identical to those removed.
 - 6. Seal piping, and test for and repair leaks.
 - 7. Seal insulation to re-establish integrity of the vapor barrier.
 - 8. The installing contractor shall attend a coordination meeting prior to the balancing of the system and a coordination meeting following the balancing of the system.
 - 9. Provide a complete set of as-built drawings prior to the TAB effort.
 - 10. Provide craftsmen of the proper trade to work with the TAB Agency to make adjustments and installation changes as required.
 - 11. The installing contractor shall dedicate the resources to accommodate all changes identified by the test and balance firm required by the contract documents in a timely manner.
 - 12. If a significant balance 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.
 - 13. The installing contractor shall furnish and install sheaves for new air handling units, if required for testing, adjusting, and balancing purposes.

1.03 SCOPE OF SERVICES

- A. This Scope of Services specifies the requirements and procedures for the mechanical systems testing, adjusting, and balancing, for the services to be conducted directly by the Owner. 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.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 23 0700
MECHANICAL INSULATION

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes mechanical insulation for ductwork, equipment, piping, appliance breechings and other installations, including the following:
 - 1. Insulation Materials:
 - a. Flexible elastomeric
 - b. Mineral fiber
 - 2. Insulating cements, adhesives, mastics, and sealants.
 - 3. Factory-applied jackets.
 - 4. Field-applied fabric-reinforcing mesh.
 - 5. Field-applied jackets.
 - 6. Tapes and securements.

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 0548 "Vibration and Seismic Controls for HVAC," 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 Section "Hydronic Distribution" for loose-fill pipe insulation in underground piping outside the building.
 - 2. Division 02 Section "Steam Distribution" for loose-fill pipe insulation in underground piping outside the building.
 - 3. Division 23 Section "Metal Ducts" for internal duct liners.

1.03 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. VOC: Volatile Organic Compound as defined by LEED v4 Credit EQc2.
- F. 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.
- G. Exposed Installations: Exposed to view. Examples include finished occupied spaces without ceilings, mechanical equipment rooms, courtyards and rooftop locations.
- H. Concealed Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings or within duct shafts.
- I. 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.

1.04 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. Insulation application at elbows, fittings, flanges, valves, couplings, and specialties for each type of insulation.
 - 3. Removable insulation at piping specialties, equipment connections, and access panels.
 - 4. Application of field-applied jackets.
 - 5. Application at linkages of control devices.
 - 6. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:
 - 7. Preformed Pipe Insulation Materials: 12-inches (300 mm) long by NPS 2 (DN 50).
 - 8. Sheet Form Insulation Materials: 12-inches (300 mm) square.
 - 9. Jacket Materials for Pipe: 12-inches (300 mm) long by NPS 2 (DN 50).
 - 10. Sheet Jacket Materials: 12-inches (300 mm) square.
 - 11. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.05 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.

1.06 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.

1.07 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.

1.08 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

2.01 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. 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.
 4. 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.
 5. 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.
 6. 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.
 7. 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.
 8. Insulation Pins and Hangers: Same as insulation manufacturer, or
 - a. AGM Industries, Inc.
 - b. GEMCO.
 - c. Midwest Fasteners, Inc.
 - d. Nelson Stud Welding.

2.02 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.
 - 5. CEMENTS AND MASTICS

- J. 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.
- K. 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.
- L. 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), 0.05 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.
- M. 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.

2.03 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).

2.04 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: 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.
- 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.

2.05 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: 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.
- 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.
 6. SECUREMENTS
- E. 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.
- F. 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. 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.
- G. Staples: Outward-clinching insulation staples, nominal ¾-inch- (19-mm-) wide, stainless-steel or Monel.
- H. Wire: 0.062-inch (1.6-mm) soft-annealed, stainless-steel.

PART 3 - EXECUTION

3.01 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.

3.02 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.

3.03 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. Manholes.
 - 5. Handholes.
 - 6. Cleanouts.

3.04 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 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."

3.05 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.

3.06 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.
 6. 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.

3.07 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.

3.08 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.

3.09 SCHEDULES

3.10 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	Duct	Minimum	Allowable	Insulation	Field	Keyed
Service	Shape	Location	Installed	Materials	Thickness	Jacket	Notes
			R-Value				
Supply Air Service (including outdoor air that has been heated or cooled)	Round, Oval	ICC,ICN	R-6	FGBK	2.00	---	(4)
		IEC,IEN	R-6	FGBK	2.00	AL	(3) (4)
		Outdoors	R-8	FGBK(O), FE	(2) 2.00	AL,SS	(4)
	Rectangular	ICC,ICN	R-6	FGBK	1.50	---	(4)
		IEC,IEN	R-6	FGBD	1.50	---	(4)
		Outdoors	R-8	FGBD,FE	(2) 2.00	AL,SS	(4)
Outdoor Air Service (prior to being heated or cooled)	Round, Oval	ICC,ICN	R-6	FGBK	2.00	---	(4)
		IEC,IEN	R-6	FGBK	2.00	AL	(3) (4)
		Outdoors	---	---	---	---	
	Rectangular	ICC,ICN	R-6	FGBK	2.00	---	(4)
		IEC,IEN	R-6	FGBD	1.50	---	(4)
		Outdoors	---	---	---	---	
Return Air Service	Round, Oval	ICC,IEC	---	---	---	---	
		ICN	R-6	FGBK	2.00	---	(4)
		IEN	R-6	FGBK	2.00	AL	(3) (4)
	Rectangular	Outdoors	R-8	FGBK(O), FE	(2) 2.00	AL,SS	(4)
		ICC,IEC	---	---	---	---	
		ICN	R-6	FGBK	2.00	---	(4)
Exhaust Air Service	Round, Oval	IEC, IEC	R-3.5	FGBK	1.50	---	(2) (4)
		ICN, IEN	R-3.5	FGBK	1.50	---	(1) (4)
		Outdoors	R-8	FGBK(O), FE	2.00	AL,SS	(1) (4)
	Rectangular	ICC, IEC	R-3.5	FGBK	1.50	---	(2) (4)
		ICN, IEN	R-3.5	FGBD	1.50	---	(1) (4)
		Outdoors	R-8	FGBD,FE	2.00	AL,SS	(1) (4)

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 only if less than 84-inches AFF.
- (5) Omit insulation if duct is expressly called out to be internally lined.

LEGEND:

ICC	Indoor, Concealed, in Conditioned space	CS	Calcium Silicate
ICN	Indoor, Concealed, in Non-conditioned space	FRW	Fire-Rated Wrap
IEC	Indoor, Exposed, in Conditioned space	AL	Aluminum
IEN	Indoor, Exposed, in Non-conditioned space	SS	Stainless Steel
FGBK	Fiberglass Insulation, 1.0-lb density, Blanket		
FGBK(O)	Fiberglass Insulation (Outdoors), 0.75-lb density, Blanket		
FGBD	Fiberglass Insulation, 3.0-lb density, Board		

FE Flexible Elastomeric

EQUIPMENT INSULATION							
Item / Description	Service	Location	Size	Allowable Materials	Insulation Thickness	Field Jacket	Keyed Notes
Shell-and-Tube Heat Exchangers	Cooling	Indoors	Any	FE	1.00	---	
		Outdoors	Any	FE	2.00	AL,SS	
	Heating	Indoors	Any	MF	2.00	---	
		Outdoors	Any	MF	2.00	AL,SS	
Expansion Tanks	Chilled Water	Indoors	Any	FE	1.00	---	
		Outdoors	Any	FE	1.00	AL,SS	
	Heating Water	Indoors	Any	MF	1.00	---	
		Outdoors	Any	MF	1.00	AL,SS	
	Other Warm Services (2)	Indoors	Any	FE,MF	1.00	---	
		Outdoors	Any	FE,MF	1.00	AL,SS	
HVAC Pumps, Air/Dirt Separators, Hydronic Filtration Equip	Chilled Water	Indoors	Any	FE	1.00	---	
		Outdoors	Any	FE	2.00	AL,SS	
	Condenser Water	Indoors	Any	FE	1.00	---	(1)
		Outdoors	Any	FE	2.00	AL,SS	(1)
	Heating Water	Indoors	Any	MF	2.00	---	
		Outdoors	Any	MF	2.00	AL,SS	
	Other Warm Services (3)	Indoors	Any	MF	2.00	---	
		Outdoors	Any	MF	2.00	AL,SS	
Steam System Equipment (4)	Steam and Condensate	Indoors	Any	MF	2.00	---	
		Outdoors	Any	MF	2.00	AL,SS	
Thermal Storage Tanks	Any	Any	Any	MF	3.00	AL,SS	
KEYED NOTES:							
<p>(1) Insulate only if used as part of a water-side economizer.</p> <p>(2) Includes heat recovery, dual-service, and closed-loop condenser water.</p> <p>(3) Includes heat recovery, dual-service, steam condensate, boiler feedwater.</p> <p>(4) Includes deaerators, CRT/P, flash tanks, flash separators, blow-off tanks.</p>							
LEGEND:							
FE Flexible Elastomeric				AL Aluminum			
MF Mineral Fiber				SS Stainless Steel			
CRT/P Condensate Receiver Tank & Pump Package							

PIPE INSULATION Services	Temperature Range °F	Size Range	Location	Allowable Materials	Thick-ness	Field Jacket	Keyed Notes
Equipment drains, blowdown, hot vents, coil condensate, makeup or fill water	below 60	¾ to 1¼	Indoors	FE	0.50	---	
		1½ & up	Indoors	MF	1.00	PVC	(3)
	above 105	All	All	MF	1.50	AL,SS	(2)
Chilled Water Piping (supply and return) Condenser Water Piping (1) (supply and return) Heat Recovery Loop Piping (supply and return) Dual-Temperature Piping (heating and cooling)	below 40	¾ to 6	Indoors	FE	1.50	---	
			Outdoors	FE	2.00	AL,SS	
		8 & up	Indoors	CG, MF	1.50	PVC	(3)
			Outdoors	CG,PI,MF	2.00	AL,SS	
	40 and up	¾ to 1¼	Indoors	FE	1.00	---	
			Outdoors	FE	2.00	AL,SS	
		1½ to 6	Indoors	FE	1.50	---	
			Outdoors	FE	2.00	AL,SS	
		8 & up	Indoors	CG,MF	1.50	PVC	(3)
			Outdoors	CG,PI,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	---	
		1½ & up	Indoors	FE,MF	1.50	---	
		Any	Outdoors	FE,MF	2.00	AL,SS	
	141-200	¾ to 1¼	Indoors	MF	1.50	---	
			Outdoors	MF	2.00	AL,SS	
	201-250 HW, ≤15#Steam, & all SCR	1½ & up	All	MF	2.00	AL,SS	(2)
		¾ to 3½	All	MF	2.50	AL,SS	(2)
	251-350 HW, 15.1#Steam to 120#Steam	4 & up	All	MF	3.00	AL,SS	(2)
		¾	All	MF	3.00	AL,SS	(2)
	>350 HW & >120#Steam	1 & 1¼	All	MF	4.00	AL,SS	(2)
		1½ & up	All	MF	4.50	AL,SS	(2)
	Refrigerant suction and hot gas piping	All	All	Indoors	FE	1.00	---
Outdoors				FE	2.00	AL,SS	
Engine Coolant	All	All	All	MF	2.00	AL,SS	(2)

KEYED NOTES:

- (1) Insulate condenser water piping only if used as part of a water-side economizer, or if freeze-protected (e.g., heat-traced) outdoors.
- (2) The specified field jacket is required only if outdoors.
- (3) The specified field jacket is required on fittings only.

LEGEND:

AFF	Above Finished Floor	CG	Cellular Glass
FE	Flexible Elastomeric	AL	Aluminum
MF	Mineral Fiber	HW	Hot Water
SCR	Steam Condensate Return	SS	Stainless Steel
PVC	Polyvinyl Chloride	#	psig

END OF SECTION

**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. Liquid tight 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. 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 ½-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. 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.
- E. 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.
- F. 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/oC).
 - 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 oF, whichever is greater.
- 7) Supply Voltage: 24 VDC.
- 8) Ambient Operating Temp.: 32 to 122 oF
- 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 thred-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-XXX-08-SL-8HN31, TT440-385U-S (30-130) F with calibration SMC (40,60) F
 - 3) Hot Water: RAF185L-S4C-XXX-08T2-SL-8HN31, TT440-385U-S (100-250) F with calibration SMC (140,180) F
 - 4) Steam: RAT185H-S4C-XXX-08T2-SL-8HN31, TT440-385U-S (150-450) F with calibration SMC (300,350) F
- G. Occupant Override: Provide wall mounted occupant override button in locations shown on drawings.
- H. 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.
 - 2. Humidistats: Humidistats must be contamination resistant, capable of ±2% RH accuracy, have field adjustable calibration and provide a linear proportional signal.
 - 3. HD20K-T91 or equivalent.
- I. 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.
- J. Carbon Dioxide Sensor:
 - 1. Wall Mount: ACI Model ESENSE-R.
 - 2. Duct Mount: ACI Model ESENSE-D.

- K. 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.
- L. Pressure Differential Switch:
 - 1. Fans: NECC model DP222 or approved equal.
- M. 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 +/- 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 +/- 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 owner's representative.

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. 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.
- C. 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.
- D. 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.
- E. 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 wherever 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.
- F. 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

THISPAGELEFT INTENTIONALLY BLANK

SECTION 23 2113
HYDRONIC PIPING

PART 1 - GENERAL

1.01 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. Glycol cooling-water piping.
 - 4. Makeup-water piping.
 - 5. Condensate-drain piping.
 - 6. Blowdown-drain piping.
 - 7. Air-vent piping.
 - 8. Safety-valve-inlet and -outlet piping.

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 0548 "Vibration and Seismic Controls for HVAC," 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 "HVAC Instrumentation and Controls" for temperature-control valves and sensors.

1.03 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.

1.04 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. Glycol Cooling-Water Piping: 175 psig (1200 kPa) at 150°F (66°C).
 4. Makeup-Water Piping: 80 psig (552 kPa) at 150°F (66°C).
 5. Condensate-Drain Piping: 150°F (66°C).
 6. Blowdown-Drain Piping: 200°F (93°C).
 7. Air-Vent Piping: 200°F (93°C).
 8. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

1.05 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.
 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. Welding certificates.
- D. Qualification Data: For Installer.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications:
 1. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. 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.
- C. 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.
- D. Comply with NFPA 70 – National Electrical Code. Do not route piping directly above electric panelboards and switchboards, or other prohibited locations.

- A. All grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
- E. All castings used for couplings housings, fittings, or valve and specialty bodies shall be date stamped for quality assurance and traceability.

1.07 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 piping installation with roof curbs, equipment supports, and roof penetrations. Roof specialties are specified in Division 07 Sections.
- C. Coordinate pipe fitting pressure classes with products specified in related Sections.
- D. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 03 Sections.
- E. 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.

1.08 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, include flowmeter, probes, hoses, flow charts, and carrying case.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Grooved Mechanical-Joint Fittings and Couplings:
 - a. Anvil International, Inc. (GruvLok products)
 - b. Central Sprinkler Company (Tyco/Grinnell products)
 - c. Star Pipe Products.
 - d. Victaulic Company.
 - 2. 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.
 - 3. Calibrated Balancing Valves:
 - a. Armstrong Pumps, Inc.
 - b. Bell & Gossett; a Xylem Brand
 - c. Hydronic Components, Inc.
 - d. IMI – TA/Victaulic.
 - e. Nibco Inc.
 - 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 & Automatic Air Vents, Expansion Tanks, Air Purgers:

- a. Amtrol, Inc.
- b. Armstrong Pumps, Inc.
- c. Bell & Gossett; a Xylem Brand.
- d. Taco.
6. Coalescing-type Air/Dirt Separators:
 - a. Amtrol, Inc.
 - b. Armstrong Pumps Inc.
 - c. Bell & Gossett; a Xylem brand.
 - d. Spirotherm, Inc.
 - e. Thrush Co., Inc.
 - f. Wessels Company
7. Chilled Water Buffer Tanks:
 - a. "CWBT Series" by Amtrol Inc.
 - b. Model V-CWB by Cemline Corporation.
 - c. Model CBT by Niles Steel Tank, a subsidiary of Bradford White Corp.
8. 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.
 - h. Victaulic Company.

2.02 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.

2.03 COPPER TUBE AND FITTINGS

- A. Annealed-Temper Copper Tubing: ASTM B88, Type K (ASTM B88M, Type A).
- B. DWV Copper Tubing: ASTM B306, Type DWV.
- C. Wrought-Copper Fittings and Unions: ASME B16.22.
- D. Solder Filler Metals: ASTM B32, 95-5 tin antimony.
- E. Grooved Mechanical-Joint Fittings: Wrought copper, conforming to ASTM B-75 alloy C12200 or ASTM B-152 alloy C11000 and ANSI B16.22, or bronze sand-casting ANSI B16.18 and UNS-C89836. Fittings shall be manufactured to copper tubing sizes, with grooves designed to accept grooved end couplings of the same manufacturer.
- F. Grooved Mechanical-Joint Couplings: Ductile iron conforming to ASTM A-536, Grade 65-45-12, coated with copper colored alkyd enamel. Housings cast with offsetting, angle-pattern bolt pads to provide rigidity, and gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings. Gasket shall be Grade "E" EPDM compound, rated for water use at not less than 230°F; UL Classified according to ANSI/NSF 61.

2.04 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.
- J. Grooved Mechanical-Joint Fittings: ASTM A536, Grade 65-45-12 ductile iron; ASTM A47, Grade 32510 malleable iron; ASTM A53, Type F, E, or S, Grade B fabricated steel; or ASTM A106, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
- K. Grooved Mechanical-Joint Couplings: Ductile- or malleable-iron housing and gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings. Gasket shall be Grade "E" EPDM compound, rated for water use at not less than 230°F; UL Classified according to ANSI/NSF 61.
 - 1. Rigid Type: Housings cast with offsetting, angle-pattern, bolt pads to provide system rigidity and support and hanging in accordance with ANSI B31.1 and B31.9. Installation-Ready for complete installation without field disassembly.
 - 2. Flexible Type: For use in locations where vibration attenuation and stress relief are required.
 - 3. NPS 14 (DN 355) and larger: two-segment couplings for pipe sizes 14" and larger, with wide-width FlushSeal gasket and lead-in chamfer on housing key.
- L. Plain End Couplings/Fittings, NPS 2 (DN 50) and smaller: Fittings shall consist of a ductile iron housing conforming to ASTM A536, Grade 65-45-12, with Installation-Ready ends orange enamel coated. Fittings complete with gasket liner, zinc-electroplated steel bolts and nuts as per the mechanical properties of ASTM A449, and 300 series stainless-steel retainer. designed for installation onto plain end pipe without prior disassembly of the fitting.

2.05 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.

2.06 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.

2.07 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 "HVAC Instrumentation and Controls" 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.

2.08 SPECIALTY VALVES

- 1. Calibrated Balancing Valves:
 - 2. General: Multi-turn y-pattern plug-style or globe-style valve with calibrated orifice or venturi.
 - 3. Body (Size ½-inch NPS): Bronze, brass, or DZR-brass body with threaded ends.
 - 4. Body (Size ¾-inch to 2-inch NPS): Bronze or DZR-brass body with threaded ends.
 - 5. Body (Size 2½-inch NPS and larger): Painted cast-iron or steel body with flanged or grooved ends.
 - 6. Plug: Resin.
 - 7. Seat/Packing: PTFE or TFE.
 - 8. Stem Seals: EPDM O-rings.
 - 9. Disc: Glass and carbon-filled PTFE.
 - 10. Pressure Gage Connections: Integral seals for portable differential pressure meter.
 - 11. Handle Style: Multi-turn dial, handle, or similar multi-turn adjustment device for manual position adjustment with memory stop to retain set position.
 - 12. Accessories: Integral pointer and calibrated scale to register degree of valve opening.
 - 13. Pressure and Temperature Rating: Same as piping in which it will be installed, as specified in Part 1 of this Section.
 - 14. Diaphragm-Operated Pressure-Reducing Valves:
 - 15. Body: Bronze or DZR-brass.
 - 16. Disc: Glass and carbon-filled PTFE.
 - 17. Seat: Brass.
 - 18. Stem Seals: EPDM O-rings.
 - 19. Diaphragm: EPT.
 - 20. Low inlet-pressure check valve.
 - 21. Inlet Strainer: Bronze or stainless-steel; removable without system shutdown.
 - 22. Valve Seat and Stem: Noncorrosive.
 - 23. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.
- B. Diaphragm-Operated Safety Valves:
 - 1. Body: Bronze or DZR-brass.
 - 2. Disc: Glass and carbon-filled PTFE.
 - 3. Seat: Brass.
 - 4. Stem Seals: EPDM O-rings.
 - 5. Diaphragm: EPT.
 - 6. Wetted, Internal Work Parts: Brass and rubber.
 - 7. Inlet Strainer: Bronze or stainless-steel; removable without system shutdown.
 - 8. Valve Seat and Stem: Noncorrosive.
 - 9. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

2.09 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).

2.10 CHEMICAL TREATMENT

- A. Bypass Chemical Feeder: Welded steel construction; 125-psig (860-kPa) working pressure; 5-gal. (19-L) capacity; with fill funnel and inlet, outlet, and drain valves.
- B. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.
- C. Ethylene and Propylene Glycol: Industrial grade with corrosion inhibitors and environmental-stabilizer additives for mixing with water in systems indicated to contain antifreeze or glycol solutions.

2.11 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 or grooved 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. Basket Strainers, 2½-inch and Larger:
 - 1. Body: ASTM A126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
 - 2. End Connections: Flanged or grooved 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.

PART 3 - EXECUTION

3.01 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.

2. Contractor's Option: Schedule 40 steel pipe; plain-end couplings and fittings; fittings complete with gasket liner, zinc-electroplated steel bolts and nuts.
- 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 PVC plastic pipe and fittings and solvent-cemented joints.
- G. Boiler or Furnace Acidic Condensate Drain Piping: All drain piping from the heat exchanger or combustion chamber of a condensing furnace or condensing boiler shall be Type 304 stainless-steel tubing, Type 304 stainless-steel fittings, and threaded or welded joints. Other materials only if approved in writing by the boiler or furnace manufacturer. If located outdoors or an unheated area, insulate as specified in Division 23 Section "Mechanical Insulation" for outdoor hydronic piping.
- H. Other hydronic heating system drains (blowdown, overflow, etc.): Use same materials and joining methods as for hot-water heating piping described above.
- I. 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 PVC plastic pipe and fittings and solvent-cemented joints or grooved mechanical couplings.
- J. Condenser water system drains (blowdown, overflow, etc.): Use same materials and joining methods as for condenser-water piping described above; or use Schedule 40 CPVC plastic pipe and fittings and solvent-cemented joints or grooved mechanical couplings.
- K. Air-Vent Piping: Same materials and joining methods as for piping specified for the service in which air vent is installed.
- L. Safety-Valve-Inlet and -Outlet Piping for HVAC Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.
- M. Contractor's Option: Standard Weight steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints will be acceptable where welded-steel piping is specified above, but only where piping is exposed to view or located above a fully-accessible lay-in ceiling.
- N. 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.

3.02 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.

3.03 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 $\frac{3}{4}$ (DN 20) ball valve, and short NPS $\frac{3}{4}$ (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. In open systems (i.e., condenser water), slope horizontal piping 0.2 percent upward back to the open-air device (i.e., cooling tower).
- 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 $\frac{3}{4}$ (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."
- T. Restrain all piping against seismic forces as specified in Division 23 Section "Vibration and Seismic Controls for HVAC."

3.04 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. Grooved Joints: Grooved joints shall be installed in accordance with the manufacturer's latest published instructions. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service. Gaskets shall be molded and produced by the grooved coupling manufacturer. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove.
 - 1. Grooved coupling manufacturer's factory trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools, application of groove, and installation of grooved piping products. Factory trained representative shall periodically visit the jobsite to ensure best practices in grooved product installation are being followed. Contractor shall remove and replace any improperly installed products.

3.05 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.

3.06 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."

3.07 CHEMICAL TREATMENT

- 1. Fill system with de-mineralized water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with de-mineralized water. **Do not use tap water.**

- B. Fill systems indicated to have antifreeze or glycol solutions with the following concentrations:
1. Glycol Cooling-Water Piping: Minimum 40 percent propylene glycol.

3.08 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.

3.09 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

THISPAGELEFT INTENTIONALLY BLANK

**SECTION 23 2213
STEAM AND CONDENSATE PIPING**

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following for LP clean steam and condensate piping:
 - 1. Pipe and fittings.

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 0548 "Vibration and Seismic Controls for HVAC," 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.

1.03 DEFINITIONS

- A. Pipe sizes used in this Specification are Nominal Pipe Size (NPS).
- B. LP Systems: Low-pressure piping operating at 15 psig (104 kPa) or less as required by ASME B31.9.

1.04 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures:
 - 1. LP Steam Piping: 15 psig (kPa) at 227°F (108°C).
 - 2. Condensate Piping: 0 psig (kPa) at 212°F (121°C).

1.05 SUBMITTALS

- A. General: Follow the procedures specified in Division 01 Section "Special Conditions."
- B. Product data, including rated capacities where applicable, furnished options and accessories, and installation instructions for:
 - 1. Low pressure pipe, fittings, and flanges.
- C. Test reports specified in Part 3 of this Section.
- D. Operation and Maintenance Data: For steam traps and air vents, to include in emergency, operation, and maintenance manuals.

1.06 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code - Steel."
- B. Pipe Welding: Qualify processes and operators according to the following:
 - 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. ASME Compliance: Comply with ASME B31.1, "Power Piping" and 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 flash tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. Comply with NFPA 70 *National Electrical Code*, including but not limited to avoidance of routing piping directly above panel boards, switch boards, and other prohibited locations.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Stop-Check Valves:

- a. Crane Co.
- b. Jenkins Valves; a Crane Company.
- c. Lunkenheimer Valves.
- d. A.Y. McDonald Mfg. Co.
2. Safety Valves:
 - a. Armstrong International, Inc.
 - b. Kunkle Valve; a Tyco International Ltd. Company.
 - c. Spirax Sarco, Inc.
 - d. Watts Water Technologies, Inc.
3. Pressure Regulating Valves:
 - a. Armstrong International, Inc.
 - b. Hoffman Specialty; Division of ITT Industries.
 - c. Leslie Controls, Inc.
 - d. Spence Engineering Company, Inc.
 - e. Spirax Sarco, Inc.
4. Steam Traps, Thermostatic Air Vents, and Vacuum Breakers:
 - a. Armstrong International, Inc.
 - b. Dunham-Bush, Inc.
 - c. Hoffman Specialty; Division of ITT Industries.
 - d. Spirax Sarco, Inc.
5. Flash Tank/Condensate Cooler:
 - a. Armstrong.
 - b. Cemline.
 - c. Hoffman Specialty; Division of ITT Industries.
 - d. Spirax Sarco, Inc.

2.02 COPPER TUBE AND FITTINGS

- A. Annealed-Temper Copper Tubing: ASTM B88, Type K (ASTM B88M, Type A).
- B. Wrought-Copper Fittings and Unions: ASME B16.22.

2.03 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A53/A53M, seamless or ERW, black steel, beveled ends, Type, Grade, and Schedule as indicated in Part 3 piping applications articles.
- B. Malleable-Iron Threaded Fittings: ASME B16.3; Classes 150 as indicated in Part 3 piping applications articles.
- C. Malleable-Iron Unions: ASME B16.39; Classes 150 hexagonal stock with ball and socket joints, metal to metal bronze seating, female threaded ends as indicated in Part 3 piping applications articles.
- D. Wrought-Steel Fittings: ASTM A234/A234M, wall thickness to match adjoining pipe.
- E. Wrought-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 1. Material Group: 1.1.
 2. End Connections: Butt welding.
 3. Facings: Raised face.
- F. Steel Pipe Nipples: ASTM A733, made of ASTM A53/A53M, black steel of same Type, Grade, and Schedule as pipe in which installed.

2.04 STAINLESS STEEL PIPE AND FITTINGS

- A. Stainless Steel Pipe, NPS 2 (DN 50) and smaller: ASTM A312, TP 304, Schedule 40 seamless stainless steel; unless otherwise indicated in Part 3 "Piping Applications" Article.
 1. Fittings: ASTM A182, Gr. F304, ANSI B16.11, 3000 lb. socket-weld.
 2. Unions: 3000 lb socket-weld, stainless steel ground joint.
- B. Stainless Steel Pipe: NPS 2½ (DN 65) and larger: ASTM A312, TP 304, Schedule 40 seamless stainless steel; unless otherwise indicated in Part 3 "Piping Applications" Article.
 1. Fittings: ASTM A403, Gr. WP304/ANSI 16.9, Butt-weld.

2. Unions: None.
3. Flanges: ASTM A182, Gr. F304, ANSI B16.5, 150 lb. standard with 1/16-inch raised face, serrated face finish and welding neck.
4. Bolts: Stud bolts, ASTM A193, Gr. B7.
5. Nuts: ASTM A194, Gr. 2H.

2.05 JOINING MATERIALS

- A. Joining Materials: As specified in Division 23 Section "Basic Mechanical Materials and Methods."
- B. Flexible Connectors: As specified in Division 23 Section "Basic Mechanical Materials and Methods."
- C. Dielectric Fittings: As specified in Division 23 Section "Basic Mechanical Materials and Methods."

2.06 GENERAL DUTY VALVES

- A. General duty valves (i.e., gate, globe, check and ball valves) are specified in Division 23 Section "Valves." Special duty valves are specified in this Article by their generic name; refer to Part 3 below, Article "VALVE APPLICATION SCHEDULE" for specific uses and applications for each valve specified.

2.07 FLEXIBLE CONNECTORS

- A. Flexible Connectors: Flexible connectors shall be corrugated stainless steel hose with stainless steel braid and flanged ends. Connector shall be rated for the design temperature and pressure of the system in which it is installed.

PART 3 - EXECUTION

3.01 PIPE APPLICATIONS

- A. Low Pressure (LPS) Steam Piping Applications:
 1. LPS Steam Piping, NPS 2 (DN 50) and Smaller: Schedule 40, Type S, Grade B, steel pipe; Class 150 malleable iron; and threaded joints.
 2. LPS Steam Piping, NPS 2-1/2 through NPS 12: Schedule 40, Type S, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
 3. Condensate Piping above Grade, NPS 2 and Smaller, shall be: Schedule 80, Type S, Grade B, steel pipe; Class 150 malleable iron; and threaded joints.
 4. Condensate Piping above Grade, NPS 2-1/2 and Larger, shall be: Schedule 80, Type S, Grade B, steel pipe; ASME B16.9 Class 150 wrought-steel welded fittings and joints.

3.02 CLEAN STEAM PIPING APPLICATIONS

- A. Clean Steam Piping, NPS 2 (DN 50) and Smaller: ASTM A312, TP 304, Schedule 40 seamless stainless steel pipe; Class 125 304 stainless steel fittings; and welded joints.
- B. Clean Steam Piping, NPS 2½ through NPS 8 (DN 65 through DN 200): ASTM A312, TP 304, Schedule 40 seamless stainless steel pipe; Class 150 304 stainless steel fittings, flanges, and flange fittings; and welded and flanged joints.
- C. Clean Steam Condensate Piping, NPS 2 (DN 50) and smaller: ASTM A312, TP 304, Schedule 80 seamless stainless steel pipe; Class 125 304 stainless steel fittings; and welded joints.
- D. Clean Steam Condensate Piping, NPS 2½ (DN 65) and larger: ASTM A312, TP 304, Schedule 80 seamless stainless steel pipe; Class 150 304 stainless steel fittings, flanges, and flange fittings; and welded and flanged joints.
- E. Clean Steam Vent Piping NPS 2 (DN 50) and Smaller: ASTM A312, TP 304, Schedule 10 seamless stainless steel pipe; Class 125 304 stainless steel fittings; and welded joints.
- F. Clean Steam Vent Piping NPS 2½ (DN 65) and larger: ASTM A312, TP 304, Schedule 10 seamless stainless steel pipe; Class 150 304 stainless steel fittings, flanges, and flange fittings; and welded and flanged joints.

3.03 ANCILLARY PIPING APPLICATIONS

- A. Makeup-water piping installed above grade shall be the following:
 - 1. Schedule 80 fittings and welded joints.

3.04 PIPING INSTALLATIONS

- A. General Locations and Arrangements: Drawings indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.
- B. Use fittings for all changes in direction and all branch connections.
- C. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.
- D. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1-inch clearance outside the insulation.
- E. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- F. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4 inch ball valve, and short 3/4 inch threaded nipple and cap.
- G. Install steam supply piping at a uniform grade of 1/4 inch in ten feet downward in the direction of flow, except where indicated otherwise on the Drawings.
- H. Install condensate return piping at a uniform grade of 1/2 inch in ten feet downward in the direction of flow, except where indicated otherwise on the Drawings.
- I. Install branch connections to supply mains with take-off out the top of the main. Where the length of a branch takeoff is less than 10 feet, pitch branch line down toward mains, 1/2 inch per 10 feet.
- J. Make reductions in pipe sizes using eccentric reducer fitting installed with the level side down.
- K. Install unions in pipes NPS 2 and smaller, adjacent to valves, at final connections to each piece of equipment, and elsewhere as indicated.
- L. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- M. Install strainers on the supply side of each control valve, pressure regulating valve, traps, and elsewhere as indicated on the Drawings.
- N. Install 3/4 inch NPS nipple and ball valve in blow down connection of all strainers 2 inch and larger, and where indicated on the Drawings. Use same size nipple and valve as blow-off connection of strainer.
- O. Install drip legs where indicated on the Drawings and at low points and natural drainage points in the system, such as at the ends on mains, bottoms of risers, and ahead of pressure regulators, control valves, isolation valves, pipe bends, and expansion joints.
 - 1. Size drip legs at vertical risers full size and extend beyond the rise. Size drip legs at other locations the same diameter as the main for steam mains smaller than 6 inches. In steam mains 6 inches and larger, provide drip legs sized 2 pipe sizes smaller than the main, but not less than 4 inches. Drip legs shall be 18 inches long where conditions allow. Drip legs shall terminate a minimum of 12 inches above the floor.
 - 2. Drip legs, dirt pockets, and strainer blowdowns shall be equipped with gate valves to allow removal of dirt and scale, unless indicated otherwise on the Drawings.
 - 3. Install steam traps close to drip legs.
- P. Refer to the Drawings for additional installation requirements.

3.05 HANGERS AND SUPPORTS

- A. General: Hanger, supports, and anchors devices and installation requirements are specified in Division 23 Section "HANGERS AND SUPPORTS."
- B. Seismic restraints are specified in Division 23 Section "Vibration and Seismic Controls for HVAC."

3.06 PIPE JOINT CONSTRUCTION

- A. Welded Joints: Comply with the requirements in ASME Code B31.1 -"Power Piping."
- B. Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads. Join pipe, fittings, and valves as follows:
 - 1. Note the 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. Align threads at point of assembly.
 - 3. Apply appropriate thread compound to the external pipe threads (except where dry seal threading is specified).
 - 4. Assemble joint to appropriate thread depth. When using a wrench on valves place the wrench on the valve end into which the pipe is being threaded.
 - 5. Damaged Threads: Do not use pipe with threads that are corroded or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.
- C. Flanged Joints: Align flanges surfaces parallel. 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 to appropriate torque specified by the bolt manufacturer.

3.07 VALVE APPLICATIONS

- A. General Duty Valve Applications: The Drawings indicate valve types to be used. Where specific valve types are not indicated the following requirements apply:
 - 1. Shutoff duty: use gate valves
 - 2. Throttling duty: use globe valves
 - 3. Install shutoff duty valves at each branch connection to supply mains, and elsewhere as indicated on the Drawings.
- B. Install drain valves at low points in mains, risers, branch lines, and elsewhere as required for system drainage.
- C. Install swing check valves as required to control flow direction, and to serve as "vacuum breakers."

3.08 TERMINAL EQUIPMENT CONNECTIONS

- A. Size for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install traps and control valves in accessible locations close to connected equipment.
- C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
- D. Install vacuum breakers downstream from control valve, close to coil inlet connection.
- E. Install a drip leg at coil outlet.

3.09 FIELD QUALITY CONTROL

- A. Preparation for testing: Prepare steam and condensate piping in accordance with ASME B 31.1 and as follows:
 - 1. Leave joints including welds uninsulated and exposed for examination during the test.
 - 2. Provide temporary restraints for expansion joints that cannot sustain the reactions due to test pressure. If temporary restraints are not practical, isolate expansion joints from testing.
 - 3. Flush system with clean water. Clean strainers.
 - 4. Isolate equipment that is not to be subjected to the test pressure from the piping. If a valve is used to isolate the equipment, its closure shall be capable of sealing against the test pressure without damage to the valve. Flanged joints at which blinds are inserted to isolate equipment need not be tested.
 - 5. Install relief valve set at a pressure no more than 1/3 higher than the test pressure, to protect against damage by expansion of liquid or other source of overpressure during the test.
- B. Testing: Test steam and condensate piping as follows:

1. Use ambient temperature water as the testing medium, except where there is a risk of damage due to freezing. Another liquid may be used if it is safe for workmen and compatible with the piping system components.
 2. Use traps installed at high points in the system to release trapped air while filling the system. Use drip legs installed at low points for complete removal of the liquid.
 3. Examine system to see that equipment and parts that cannot withstand test pressures are properly isolated. Examine test equipment to ensure that it is tight and that low-pressure filling lines are disconnected.
 4. Subject piping system to a hydrostatic test pressure which at every point in the system is not less than 1.5 times the design pressure. The test pressure shall not exceed the maximum pressure for any vessel, pump, valve, or other component in the system under test.
 5. After the hydrostatic test pressure has been applied for at least 4 hours, examine the system for leakage. Eliminate leaks by tightening, repairing, or replacing components as appropriate, and repeat hydrostatic test until there are no leaks.
- C. Design and Test Pressures for the steam and condensate piping shall be as follows:
1. Low Pressure Steam: design pressure = 100 psig; test pressure = 150 psig.
 2. Condensate Return: design pressure = 100 psig; test pressure = 150 psig.

3.10 CLEANING

- A. Flush the system with clean water. Remove, clean, and replace strainer screens.

END OF SECTION

SECTION 23 3113
METAL DUCTS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes metal ducts 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 ducts and fittings.
 3. Double-wall round ducts and fittings.
 4. Sheet metal materials.
 5. Duct liner.
 6. Sealants and gaskets.
 7. Hangers and supports.
 8. Seismic-restraint devices.

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 0548 "Vibration and Seismic Controls for HVAC," 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 "Access Doors and Frames" for wall- and ceiling-mounted access doors and for access to concealed ducts.
 2. Division 23 Section "Mechanical Insulation."
 3. Division 23 Section "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
 4. Division 23 Section "Air Terminal Units" for temperature control terminal units.
 5. Division 23 Section "Diffusers, Registers and Grilles."
 6. Division 23 Section "HVAC Instrumentation and Controls" for automatic control dampers and actuators.
 7. 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. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA *HVAC Duct Construction Standards – Metal and Flexible* and SMACNA's "Seismic

Restraint Manual: Guidelines for Mechanical Systems.” Seismic force factors are specified in Division 20 Section “Seismic Protection.”

- D. 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. Liners and adhesives.
 2. Sealants and gaskets.
 3. Seismic-restraint devices.
 4. Manufactured ductwork and duct fittings (if applicable).
 5. MSDS (Material Safety Data Sheet) for each adhesive and sealant furnished.
 6. Sheet metal thicknesses.
 7. Joint and seam construction and sealing.
 8. Reinforcement details and spacing.
 9. Materials, fabrication, assembly, and spacing of hangers and supports.
 10. Shop Drawings: CAD-generated and drawn to 1/4-inch equals 1 foot (1:50) scale. Show fabrication and installation details for metal ducts as follows:
 11. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 12. Factory- and shop-fabricated ducts and fittings.
 13. Duct layout indicating sizes and pressure classes.
 14. Elevations of top and bottom of ducts.
 15. Dimensions of main duct runs from building grid lines.
 16. Fittings.
 17. Reinforcement and spacing.
 18. Seam and joint construction.
 19. Penetrations through fire-rated and other partitions.
 20. Equipment installation based on equipment being used on Project.
 21. Duct accessories, including access doors and panels.
 22. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.
- 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. QUALITY ASSURANCE
- E. 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.
- F. NFPA Compliance: Comply with NFPA 90A-2018 *Standard for the Installation of Air Conditioning and Ventilating Systems*.
- G. AMCA Compliance: All spiral ducts shall bear the AMCA Certified Ratings Program seal for Air Leakage.
- H. ASHRAE Compliance: Applicable requirements in ASHRAE Standard 62.1-2016, Section 5 - “Systems and Equipment” and Section 7 – “Construction and System Start-Up.”
- I. ASHRAE Compliance: Applicable requirements in ASHRAE Standard 90.1-2016, Section 6.4.4 – “HVAC System Construction and Insulation.”

1. REFERENCES

- J. ANSI/SMACNA Standard 001-2008 *Seismic Restraint Manual; Guidelines for Mechanical Systems*, as published by the Sheet Metal and Air Conditioning Contractors National Association. 3rd ed. Chantilly, VA: SMACNA, 2008. All references to this document throughout this Section refer to this specific edition.
- K. 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.
- L. ACR 2006: National Air Duct Cleaners Association. *Assessment, Cleaning, & Restoration of HVAC Systems*. 4th ed. Washington, DC: NADCA, 2006. All references to this document throughout this Section refer to this specific edition.

1.06 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. Anti-microbial Coating for Sheet Metal:
 - a. Bio Shield Tech, LLC
 - b. McGill AirFlow LLC "SilverGuard"
 - c. AK Steel Corporation / AgION Technologies, Inc.
 - 2. Fibrous-Glass Duct Liner:
 - a. CertainTeed Corporation "ToughGard."
 - b. Ductmate Industries, Inc. "PolyArmor" (polyester duct liner alternative)
 - c. Knauf Fiber Glass GmbH "Duct Liner E-M."
 - d. Johns Manville Corporation "Permacote Linacoustic."
 - e. Owens-Corning Fiberglas Corporation "Aeroflex Plus."
 - 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: G60 (Z180) or G90 (Z275).
 - 2. Finishes for Surfaces Exposed to View: Mill-phosphatized.
 - 3. 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.
- D. 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.
- E. Factory- or Shop-Applied Antimicrobial Coating:
 - 1. Apply to the surface of sheet metal that will form the interior surface of the duct. An untreated clear coating shall be applied to the exterior surface.
 - 2. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
 - 3. Coating containing the antimicrobial compound shall have a hardness of 2H, minimum, when tested according to ASTM D3363.
 - 4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
 - 5. Antimicrobial coating on sheet metal is not required for duct containing liner treated with antimicrobial coating.
- 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 DUCT LINER

- A. Fibrous-Glass Liner: ASTM C1071 flexible bonded mat of glass fiber; surfaces exposed to airstream shall be coated to prevent erosion of glass fibers. Comply with NFPA 90A and with NAIMA AH124.
- B. Thickness: 1-inch (25 mm).
- C. Density: 1½-pound.
- D. Thermal Conductivity (k-Value): Not more than 0.26 at 75°F (0.037 at 24°C) mean temperature per ASTM C518.
- E. Moisture Resistance: Not more than 3% by weight at 120°F, 95% relative humidity. Insulation shall not support or promote mold or fungus growth per UL 181, ASTM C665, and ASTM G21 tests.

- F. Performance: Rated for 4000 fpm, 150°F air temperature. Sound absorption coefficients per ASTM C423 Type "A" mounting shall be as follows:
 - 1. 125 Hz Octave Band: 0.10
 - 2. 250 Hz Octave Band: 0.25
 - 3. 500 Hz Octave Band: 0.50
 - 4. 1000 Hz Octave Band: 0.70
 - 5. 2000 Hz Octave Band: 0.82
 - 6. 4000 Hz Octave Band: 0.83
 - 7. NRC: 0.60
- G. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E84.
- H. Liner Adhesive: Water based duct liner adhesive equal to Foster 85-60 and/or Childers CP-127. Comply with NFPA 90A and with ASTM C916.
- I. Mechanical Fasteners: Galvanized steel suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in duct.
 - 1. Tensile Strength: Indefinitely sustain a 50-lb- (23-kg-) tensile, dead-load test perpendicular to duct wall.
 - 2. Fastener Pin Length: As required for thickness of insulation and without projecting more than 1/8-inch (3 mm) into airstream.
 - 3. Adhesive for Attaching Mechanical Fasteners: Comply with fire-hazard classification of duct liner system.

2.04 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.

2.05 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.

2.06 SHOP APPLICATION OF LINER IN RECTANGULAR DUCTS

- A. General: In general, supply air and outside air ducts will be externally insulated, not internally lined. Internal duct liner is not an acceptable substitute for external insulation. Use duct liner only where indicated.
- B. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
- C. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
- D. Butt transverse joints without gaps and coat joint with adhesive.
- E. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
- F. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and standard liner product dimensions make longitudinal joints necessary.
- G. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
 - 1. Fan discharges.
 - 2. Intervals of lined duct preceding unlined duct.
 - 3. Upstream edges of transverse joints in ducts where air velocities are greater than 2500 fpm (12.7 /s) or where indicated.

- H. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.07 ROUND 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. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA *HVAC Duct Construction Standards – Metal and Flexible* unless otherwise indicated.
 - 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: Fabricate gored elbows unless space restrictions require mitered elbows.
 - 6. HANGERS AND SUPPORTS
- I. 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.

- J. 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.
- K. 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.
- L. 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.
- M. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- N. 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.

2.08 SEISMIC-RESTRAINT DEVICES

- A. General Requirements for Restraint Components: As defined in Division 20 Section “Seismic Protection.”
- B. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- C. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.
- D. Restraint Cables: ASTM A603, galvanized-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips. Use ASTM A492, stainless-steel cables where attached to aluminum or stainless-steel ducts.
- E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Reinforcing steel angle clamped to hanger rod is also acceptable.
- F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E488.

2.09 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. Primer for galvanized steel ducts shall be galvanized metal primer with total dry film thickness of 1.2 mils; such as Moore #155 or equal. Coordinate brand and selection with the party responsible for performance of Division 09 Painting Sections.

- C. Primer for aluminum shall be acrylic- or alkyd-based metal primer specifically recommended by the manufacturer for use over aluminum, with total dry film thickness of 1.4 mils; such as Moore #163 or equal. 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. Constant-volume Supply Ducts: 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. Return Ducts: 2-inch wg (500 Pa), positive or negative pressure as applicable.
 5. Transfer Ducts: 1/2-inch wg (125 Pa).
 6. Exhaust Ducts: 3-inch wg (500 Pa), positive or negative pressure as applicable.

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. DUCT INSTALLATION
- B. Construct and install ducts according to *SMACNA HVAC Duct Construction Standards – Metal and Flexible* unless otherwise indicated.
- C. Install ducts in maximum practical lengths with fewest possible joints.
- D. Install ducts with fewest possible joints. Install fabricated fittings for changes in directions, size, and shape and for connections.
- E. 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.
- F. 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.
- G. Install ducts with a clearance of 1-inch (25 mm), plus allowance for insulation thickness.
- H. 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.
- I. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.
- J. Install duct accessories as required by Division 23 Section “Duct Accessories.”
- K. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.

- L. 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.
- M. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.
- N. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- O. 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).
- P. 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."
- Q. Install ducts with hangers and braces designed to withstand, without damage to equipment, seismic forces as further described in Division 20 Section "Seismic Protection."
- R. 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.
- S. Paint interiors of metal ducts that do not have duct liner, for 24-inches (600 mm) upstream of registers and grilles. Apply one coat of flat, black, latex finish coat over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 Painting Sections.

3.03 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.
 - 2. HANGING AND SUPPORTING

- F. Install rigid round, rectangular, and flat-oval metal duct with support systems indicated in SMACNA *HVAC Duct Construction Standards – Metal and Flexible*.
- G. Support horizontal ducts within 24-inches (600 mm) of each elbow and within 48-inches (1200 mm) of each branch intersection.
- H. Support vertical ducts at one- or two-story intervals (i.e., 12 feet (3.66 m) to 24 feet (7.32 m)).
- I. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.
- J. Install concrete inserts before placing concrete.
- K. 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.
- L. 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.
- M. Provide seismic bracing and restraints as further described in Division 20 Section "Seismic Protection."

3.04 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.

3.05 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.

3.06 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 fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet.
 5. 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.

3.07 CLEANING EXISTING SYSTEMS

- A. Use service openings, as required, for physical and mechanical entry and for inspection.
1. Use existing service openings where possible.
 2. Create other openings to comply with duct standards.
 3. Disconnect flexible ducts as needed for cleaning and inspection.
 4. Reseal rigid fiberglass duct systems according to NAIMA recommended practices.
 5. Remove and reinstall ceiling sections to gain access during the cleaning process.
- B. Mark position of dampers and air-directional mechanical devices before cleaning and restore to their marked position on completion.
- C. Particulate Collection and Odor Control:
1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron size (or larger) particles.
 2. When venting vacuuming system to the outside, use filtration to contain debris removed from HVAC system, 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.
 7. Dedicated exhaust and ventilation components and makeup air systems.
- 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 fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
 5. Clean coils and coil drain pans according to ACR 2006. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
 6. Provide operative drainage system for washdown procedures.
 7. Biocidal Agents and Coatings: Apply biocidal agents if fungus is present. Apply biocidal agents according to manufacturer's written instructions after removal of surface deposits and debris.
- F. Cleanliness Verification:
1. Verify cleanliness after mechanical cleaning and before application of treatment, including biocidal agents and protective coatings.
 2. Visually inspect metal ducts for contaminants.
 3. Where contaminants are discovered, re-clean and reinspect ducts.
 4. 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

THISPAGELEFT INTENTIONALLY BLANK

**SECTION 23 3300
DUCT ACCESSORIES**

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Backdraft dampers.
 - 2. Manual volume dampers.
 - 3. Automatic control dampers.
 - 4. Fire dampers, smoke dampers, and fire/smoke dampers.
 - 5. Turning vanes.
 - 6. Duct-mounted access doors.
 - 7. Flexible connectors.
 - 8. Flexible ducts.
 - 9. Duct accessory hardware.

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 0548 "Vibration and Seismic Controls for HVAC," 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 "HVAC Instrumentation and Controls" for actuators associated with automatic control dampers.
 - 2. Division 26 Section "Fire Alarm Systems" for duct-mounted fire detectors.

1.03 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.

1.04 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.

1.05 REFERENCED STANDARDS

- A. Sheet Metal and Air Conditioning Contractors' National Association. *HVAC Duct Construction Standards – Metal and Flexible*. 3rd ed. Chantilly, VA: SMACNA, 2005.

PART 2 - PRODUCTS

2.01 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. 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.
3. 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.
4. 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.
5. Flexible Ducts:
 - a. #087 by Atco Rubber Products, Inc.
 - b. Type 8M by Flexmaster USA, Inc.
 - c. "M-KE" by ThermaFlex.

2.02 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 G60 (Z180) or 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.

2.03 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.

2.04 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.

2.05 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: 1/2-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 or 120-Volt AC.
9. Test and reset switches, damper-mounted.

L. Accessories: Auxiliary switches for fan control or position indication.

2.06 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.

2.07 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

2.08 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."

2.09 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.

2.10 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

3.01 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 security bars where indicated.
- I. Install duct silencers rigidly to ducts.
- J. 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.
- K. Install access doors with swing against duct static pressure.
- L. Label access doors according to Division 23 Section "Basic Mechanical Materials and Methods" to indicate the purpose of access door.
- M. Install flexible connectors to connect ducts to equipment using metal-edged connections or flanges.
- N. 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.
- O. Connect air devices to ducts with flexible duct clamped or strapped in place.
- P. Connect air devices to ducts directly or with a minimum 24-inch (900-mm) and a maximum 48-inch (1800-mm) length of flexible duct clamped or strapped in place.
- Q. 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.
- R. Install duct test holes where required for testing and balancing purposes.

3.02 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.

MU PROJECT NO. CP245321
OWH PROJECT NO. 2498000

Patient Care Tower - T1230 MRI Room
Bid Package
July 9, 2024

END OF SECTION

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.

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 23 0548 "Vibration and Seismic Controls for HVAC," 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 "HVAC Instrumentation and Controls" for control devices and installation associated with air terminals.

1.02 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, seismic restraints, and vibration isolation.
- C. Verify compliance with each third-party test or rating Standard referenced in the "Quality Assurance" subsection below.
- D. Wiring Diagrams: Detail wiring for power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.
- 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.

1.03 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*.

1.04 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. Hart & Cooley, Inc.
 4. Greenheck Inc.
 5. Price Industries Inc.
 6. 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.
- B. 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.
- E. Requirements for Seismic Restraint: As described in Division 20 Section "Seismic Protection."

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.
 - 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- 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 SEISMIC-RESTRAINT-DEVICE INSTALLATION

- A. Install hangers and braces designed to support the air terminal units and to restrain against seismic forces required by applicable building codes, as further described in Division 20 Section "Seismic Protection."
- B. Install seismic-restraint devices for air terminal units using ANSI/SMACNA Standard 001-2008 *Seismic Restraint Manual; Guidelines for Mechanical Systems*, as issued by the Sheet Metal and Air Conditioning Contractors National Association, Inc., 2008; Chantilly, Virginia; Third Edition.

3.04 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 in accordance with Details on Drawings. 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.

3.05 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 "HVAC Instrumentation and Controls."

3.06 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.

3.07 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

SECTION 23 3713
DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes ceiling- and wall-mounted diffusers, registers, and grilles.

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 0548 "Vibration and Seismic Controls for HVAC," 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 "Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.
 2. Division 23 Section "Testing, Adjusting, and Balancing" for balancing diffusers, registers and grilles.

1.03 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.

1.04 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. Samples 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 note on Schedule.
- C. Samples for Initial Selection: Submit sample diffusers, registers, and grilles with factory-applied color finishes; where required or indicated by note on Schedule.

1.05 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

2.01 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.
- F. Seismic Restraint: Earthquake ceiling tabs are required on all diffusers, registers, and grilles installed in a lay-in ceiling, to provide positive connection of air device to ceiling runners. Refer to Division 20 Section "Seismic Protection" for additional seismic requirements.

2.02 PRODUCT SPECIFICATIONS

- A. Perforated-Face Ceiling Diffuser: 24 gage steel (use 0.040-inch aluminum where scheduled) face with 3/16-inch holes on staggered ¼-inch centers for at least 50% free area. Provide integral pattern controllers on the back of the faceplate for supply models, field-adjustable for 1, 2, 3, or 4-way discharge. Faceplate shall have latches and be hinged on one side for service. The faceplate and border of supply and return grilles shall be identical. 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. 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. 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.

PART 3 - EXECUTION

3.01 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

THISPAGELEFT INTENTIONALLY BLANK

SECTION 23 8123
COMPUTER-ROOM AIR-CONDITIONING SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Ceiling-mounted computer-room air conditioners.

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 0548 "Vibration and Seismic Controls for HVAC," 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.

1.03 DEFINITION

- A. BAS: Building automation system.

1.04 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Computer-room air conditioners shall withstand the effects of earthquake motions determined according to Division 20 Section "Seismic Protection." The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.05 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For computer-room air conditioners. 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.
- C. Wiring Diagrams: For power, signal, and control wiring; differentiating between field-installed and factory-installed wiring.
- D. Seismic Qualification Certificates: For computer-room air conditioners, 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.
- E. Field quality-control reports.
- F. Warranty: Sample of special warranty.
- G. Operation and Maintenance Data: For computer-room air conditioners to include in emergency, operation, and maintenance manuals.

1.06 SPARE MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fan Belts: One complete set for each belt-driven fan.
 - 2. Filters: One complete set of filters for each unit.

1.07 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
 - 1. Fabricate and label refrigeration system to comply with ASHRAE 15-2016 Safety Standard *for Refrigeration Systems*.
 - 2. Applicable requirements in ASHRAE 62.1-2016, Section 4 – “Outdoor Air Quality,” Section 5 – “Systems and Equipment,” Section 6 – “Ventilation Rate Procedures,” and Section 7 – “Construction and Startup.”
- C. Energy Compliance: No condensing unit and/or split system will be accepted which does not meet Table 6.8.1 values in ASHRAE Standard 90.1-2016 *Energy Standard for Buildings Except Low-Rise Residential Buildings*.
- D. ASME Compliance: Fabricate and label water-cooled condenser shell to comply with ASME Boiler and Pressure Vessel Code: Section VIII, “Pressure Vessels,” Division 1.

1.08 COORDINATION

- A. Coordinate layout and installation of computer-room air conditioners 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.

1.09 WARRANTY

- A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of computer-room air conditioners that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Compressors: Manufacturer’s standard, but not less than five years from date of Substantial Completion.
 - 2. Warranty Period for Humidifiers: Manufacturer’s standard, but not less than three years from date of Substantial Completion.
 - 3. Warranty Period for Control Boards: Manufacturer’s standard, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. APC by Schneider Electric.
 - 2. Compu-Aire, Inc.
 - 3. Stulz-ATS
 - 4. Vertiv Corporation.

2.02 CEILING-MOUNTED UNITS

- A. Description: Self-contained, factory assembled, prewired, and pre-piped; consisting of cabinet, fan, filters, and controls; for horizontal ceiling mounting to fit T-bar ceiling opening of 24 by 48 inches (610 by 1220 mm).
- B. Cabinet: Galvanized steel with baked-enamel finish, insulated with 1/2-inch- (13-mm-) thick duct liner.
- C. Supply-Air Fan: Forward curved, centrifugal, and directly driven by two-speed motor.
- D. Hydronic Cooling Coil: Seamless copper tubes expanded into aluminum fins with two-way control valve.
 - 1. Cooling Medium: Water.
- E. Filter: 1-inch- (25-mm-) thick, disposable, glass-fiber media; MERV-7.

- F. Electrode Steam Humidifier: Self-contained, microprocessor-controlled unit with disposable, polypropylene-plastic cylinders, and having field-adjustable steel electrodes and stainless-steel steam dispersion tube.
 - 1. Plumbing Components and Valve Bodies: Plastic, linked by flexible rubber hosing, with water fill with air gap and solenoid valve incorporating built-in strainer, pressure-reducing and flow-regulating orifice, and drain with integral air gap.
 - 2. Control: Fully modulating to provide gradual 0 to 100 percent capacity with field-adjustable maximum capacity; with high-water probe.
 - 3. Drain Cycle: Field-adjustable drain duration and drain interval.
- G. Disconnect Switch: Non-automatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.
- H. Control System: Unit-mounted panel with main fan contactor, compressor contactor, compressor start capacitor, control transformer with circuit breaker, solid-state temperature-and humidity-control modules, time-delay relay, and high-temperature thermostat. Provide solid-state, wall-mounted control panel with start-stop switch, adjustable humidity set point, and adjustable temperature set point.

2.03 FAN MOTORS

- A. 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. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
- B. Power Cable Raceway: Any and all power cable installed inside the unit proper, such as (but not limited to) power cabling to the fan/motor assembly, shall be installed inside flexible or rigid conduit as further specified in Division 26 Section "Raceways." Cabling installed inside a separate dedicated power or control enclosure need not be installed in raceway.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for hydronic piping systems to verify actual locations of piping connections before equipment installation.
- C. Examine walls, floors, and roofs for suitable conditions where computer-room air conditioners will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Layout and install computer-room air conditioners and suspension system coordinated with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.
- B. Install computer-room air conditioners level and plumb, maintaining manufacturer's recommended clearances. Install according to AHRI Guideline B. Comply with requirements for vibration isolation devices specified in Division 23 Section "Mechanical Vibration Isolation." Comply with requirements for hangers and supports (suspended units only) as specified in Division 23 Section "Hangers and Supports."
- C. See Division 23 Section "Basic Mechanical Materials and Methods" for anchorage and base requirements.

3.03 CONNECTIONS

- A. Piping installation requirements are specified in other heating, ventilating, and air-conditioning Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Water Connections: Comply with applicable requirements in Division 22 Section "Domestic Water Piping." Provide adequate connections for humidifier makeup and flushing system.
- D. Chilled Water and Condensate drain Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping." Provide shutoff valves in inlet and outlet piping to heating coils.

3.04 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
 - 2. After installing computer-room air conditioners and after electrical circuitry has been energized, test for compliance with requirements.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Prepare test and inspection reports. Computer-room air conditioners will be considered defective if they do not pass tests and inspections.
- C. After startup service and performance test, change filters and flush humidifier.

3.05 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.06 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain computer-room air conditioners.

END OF SECTION

SECTION 23 8413
HUMIDIFIERS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following types of humidifiers:
1. Direct steam injection.

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 0548 "Vibration and Seismic Controls for HVAC," 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 HVAC ducts which will house humidifier steam dispersion grids.
 2. Division 23 Section "Hydronic Piping" for makeup and drain lines associated with the humidifiers.
 3. Division 23 Section "Steam and Condensate Piping" for steam and condensate lines, steam traps, strainers, and other specialties associated with the humidifiers.
 4. Division 23 Section "Computer-Room Air-Conditioners" for humidifiers associated with those units, not specified herein.
 5. Division 23 Section "HVAC Instrumentation and Controls" for humidistats and humidification controls.

1.03 SUBMITTALS

- A. Product data including rated capacities of selected models, weights (shipping, installed, and operating), supports, weight on each support, required clearances, furnished specialties, and accessories.
- B. Shop Drawings: Detail fabrication and installation of humidifiers. Include piping details, plans, elevations, sections, details of components, manifolds, injection and dispersion elements, and attachments to other work. Show support locations, type of support, weight on each support, required clearances, and other details.
- C. Wiring Diagrams: Power, signal, and control wiring. Clearly differentiate between factory- and field-installed wiring.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For humidifiers to include in operation and maintenance manuals specified in Division 01. Include detailed manufacturer's instructions on startup, shutdown, troubleshooting, preventive maintenance, and servicing. Include parts list and list of accessories.

1.04 QUALITY ASSURANCE

- A. Comply with AHRI Standard 640-2017 *Performance Rating of Commercial and Industrial Humidifiers*.

1.05 EXTRA MATERIALS

- A. Furnish one replacement electrode cylinder with each self-contained humidifier, that matches products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.06 COORDINATION

- A. Coordinate location and installation of humidifiers with manifolds in ducts and air-handling units or occupied space. Revise locations and elevations to suit field conditions and to ensure proper humidifier operation.
- B. Coordinate physical size of humidifier steam dispersion manifold with interior dimensions of the air handling unit for uniform steam distribution. At contractor's discretion, ship steam dispersion grids with complete written mounting instructions to air handling unit manufacturer's facility for incorporation into air handling units.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle humidifiers according to manufacturer's recommendations.
- B. Store humidifiers on elevated platforms in a dry location.

1.08 WARRANTY

- A. General Warranty: Extended warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Manufacturer's Extended Warranty: Submit written warranty, signed by manufacturer, agreeing to repair or replace any component up to and including the entire unit, due to defects in materials or workmanship. Warranty must include parts, labor, shipping and handling charges, and applicable taxes, for no out-of-pocket cost to the Owner. Extended warranty period shall be manufacturer's standard, but not less than two years (2) after date of Substantial Completion.

PART 2 - PRODUCTS

2.01 HUMIDIFIERS, GENERAL

- A. Manufacturers: Subject to compliance with requirements, provide humidifiers and humidifier accessory products by one of the following manufacturers:
 - 1. Armstrong International, Inc.
 - 2. Herrmidifier Co., Inc.
 - 3. National Environmental Products Ltd. "Neptronic"
 - 4. Nortec Humidity Inc.
 - 5. Pure Humidifier Company.
 - 6. Research Products Corporation "DriSteem"
- B. Water Source: Cold domestic tap water.

2.02 DIRECT STEAM-INJECTION HUMIDIFIERS

- A. Steam Separator: ASTM A666, Type 304 stainless-steel, with internal baffles and a separate humidifier control valve.
- B. Humidifier Control Valve: Comply with ANSI B16.15 Class 250; equal percentage flow characteristics; brass or bronze body globe valve with stainless-steel seat, stem and plug.
 - 1. Actuator: Electric modulating with spring return; normally closed.

2.03 SELF-CONTAINED, ELECTRODE STEAM-GENERATING HUMIDIFIERS

- A. Electrode Cylinder: Replaceable plastic assembly complying with UL 499, with internal electrodes to create heat caused by electrical resistance in the conductive water itself. The humidifier shall be capable of operating on water with a conductivity of 100-1500 micromho.
- B. Cabinet: Sheet metal enclosure for housing heater cylinder, electrical wiring, components, controls, and control panel. Enclosure shall include baked-enamel finish, hinged or removable access door, and threaded outlet in bottom of cabinet for drain piping.
- C. Water connection shall include integral air gap to prevent back-siphoning.

- D. Controls: Automatic flush, drain, and fill cycles; automatically control output of steam to within $\pm 5\%$ of setpoint.

2.04 STEAM-INJECTION DISPERSION MANIFOLD

- A. Vapor Hose Kit: Provide a 10-foot section of vapor hose, stainless-steel hose clamps and a two-piece duct plate for sealing duct opening around the dispersion tube. Top of cabinet shall be fitted with a vapor hose connector.
- B. Steam Dispersion Grid: Tube bank consisting of a header and required quantity of multiple dispersion tubes, factory assembled in a rack sized to fit across entire cross-section of duct or plenum and equipped with mounting hardware.
1. Header shall be constructed of ASTM A666, Type 304 or 316 stainless-steel and shall be fitted with 1-inch, 1½-inch or 2-inch tee outlets for dispersion tube connections. The header shall be baffled or otherwise internally balanced to ensure uniform steam flow to each dispersion tube.
 2. The dispersion tubes shall be constructed of ASTM A666, Type 304 or 316 stainless-steel and shall be engineered to limit airstream sensible heat gain to a maximum of 3°F when no humidification is required.
 3. Vapor emission ports shall be sized and located along the dispersion tube for uniform steam distribution across the grid. Dispersion tubes shall either be fully jacketed with punched emission ports, or unjacketed with emission port sleeves extending to the center of the dispersion tube; to minimize condensate carryover.
 4. Steam shall be absorbed into the airstream such that no moisture accumulates on interior air handling unit surfaces more than 18 inches beyond the centerline of the steam dispersion grid at 500 fpm face velocity. The dispersion tube quantity and spacing, and vapor outlet ports quantity and spacing, shall be factory-engineered to meet this absorption requirement.
 5. Provide 1/8-inch thick, PVDF insulation on thermal dispersion tubes and humidifier grid header. Insulation shall have a maximum rating under UL 723 (ASTM E84) flame spread/smoke developed of 25/50; high temperature rated for 300°F continuous operation; closed-cell construction that will not absorb moisture and therefore not support microbial growth; zero particle erosion per ASTM C1071, and resistant to UV light.
- C. Humidifier controls hardware shall include the following features and functions:
1. A brass- or bronze-body solenoid-operated fill valve, factory-mounted and factory-wired.
 2. A motor-driven brass- or bronze-body drain valve factory-mounted and factory-wired.
- D. The following humidifier controls hardware is intended to be furnished and installed as the work of Division 23 Section "Control Systems":
1. Wall-mounted humidistats.
 2. Airflow switch for preventing humidifier operation without airflow.
 3. Aquastat mounted on steam condensate return piping to prevent cold operation of humidifier.

2.05 ACCESSORY HARDWARE

- A. Condensate Tempering Tank: Type 304 stainless-steel cylindrical mixing chamber and internal baffles; self-contained thermostatically controlled metering valve set at 140°F for blending tap water with hot condensate drainage prior to discharge to sewer.
1. Fabricate with tappings for condensate outlet, condensate inlet, makeup water inlet, and legs.
 2. Subject to compliance with requirements, example of acceptable device is "Drane Cooler" by Dri-Steem Corporation, or equal.
 3. Alternate methods of ensuring a discharge drain and/or blowdown temperature no higher than 140°F may be submitted to the Engineer for consideration.

2.06 FIELD PIPING

- A. As specified in Division 23 Section "Steam and Condensate Piping."

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Examine air-handling units, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance. Examine roughing-in for piping systems to verify actual locations of piping connections before humidifier installation. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Install humidifiers as indicated, in accordance with manufacturer's written instructions and AHRI 640. Install humidifiers with required clearance for service and maintenance.

3.02 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
 - 1. Install piping adjacent to humidifiers to allow service and maintenance.
 - 2. Install shutoff valve, strainer, backflow preventer, and union in humidifier makeup line.
- B. Install electrical devices and piping specialties furnished by manufacturer but not factory mounted.
- C. Connect wiring and ground equipment according to Division 26 Sections.

3.03 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.

3.04 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain humidifiers.
 - 1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
 - 2. Review data in maintenance manuals. Refer to Division 01.
 - 3. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION

SECTION 26 0500
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. This Section specifies the basic requirements for electrical installations and includes requirements common to all sections of Division 26. It expands and supplements the requirements specified in sections of Division 00. This section is also applicable to Division 28 "Electronic Safety and Security".
- B. Drawings and general provisions of the Contract, including general and supplementary conditions and specification sections Divisions 00 through 01, apply to this Section.
- C. Codes and Standards: All equipment, material and installations shall comply with applicable codes, standards, and installation practices. Comply with the requirements of the applicable local building codes, the applicable NEC, all local rules and regulations including those of the fire authorities. Comply with all applicable NFPA standards. All material and equipment shall be listed by the Underwriters Laboratories (UL) standard that is applicable for the specific purpose of the material and equipment. The National Electrical Code, National Electrical Manufacturer's Association (NEMA) Standards, and applicable ANSI and IEEE standards shall apply to the pertinent materials, equipment, and installation practices. Testing shall be in accordance with the applicable International Electrical Testing Association (NETA) standards.
 - 1. These specifications include references to the 2014 edition of the NFPA 70 "National Electrical Code." Where a different edition of the NEC has been adopted by the local Authority Having Jurisdiction, the references associated with that edition of the Code shall be applicable.

1.02 SUMMARY OF WORK

- A. The word "furnish" means supply for use, the word "install" means install in its proper location and connect up complete and ready for operation, and the word "provide" means to furnish and install.
- B. Provide all new materials as indicated on the drawings and specifications and all items required to make the electrical system complete and in working order.
- C. System descriptions included in scope of work are as follows:
 - 1. Electrical power systems, including luminaires, distribution equipment, motors, wiring devices, etc.
 - 2. Grounding system.
 - 3. Fire alarm system.
 - 4. Power and communications for temperature control system.
 - 5. Wiring of equipment furnished by the Owner or other Divisions.
 - 6. Selective demolition work and modification of existing systems and equipment.
 - 7. Low voltage systems as described in Divisions 27 and 28.
 - 8. Low voltage systems rough-in, as indicated on drawings, for installation of low voltage equipment by others.
- D. Work not included:
 - 1. Temperature control wiring for plumbing and HVAC equipment (unless otherwise indicated) shall be by other Divisions.

1.03 WORK SEQUENCE

- A. All work that produces excessive noise or interference with normal building operations shall be coordinated and scheduled with the Owner. Such work may require scheduling of work after occupied hours or weekends. The Owner reserves the right to determine when such work is conducted.

1.04 ELECTRICAL COORDINATION DRAWINGS

- A. Prepare a set of coordination drawings showing major elements, components, and systems of electrical equipment and materials in relationship with other building components. Prepare drawings to an accurate scale of 1/4 inch = 1 foot-0 inches or larger. Indicate the locations of all equipment and materials, including clearances for servicing and maintaining equipment.
- B. Prepare floor plans, reflected ceiling plans, elevations, sections, and details to conclusively coordinate and integrate all installations. Show National Electrical Code-required clearances, maintenance access, and equipment removal clearances. Indicate locations where space is limited and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
 - 1. Equipment room layouts.
 - 2. Specific equipment installations, including, but not limited to the following:
 - a. Control panels
 - b. Equipment connections
 - c. Panelboards
 - d. UPS Systems
 - 3. Wiring diagrams: Indicating field-installed electrical power and control wiring and cabling layouts, overcurrent protective devices, equipment, and equipment connections.
 - 4. Work in pipe spaces, chases, trenches and tunnels.
 - 5. Exterior wall penetrations.
 - 6. Ceiling plenums which contain piping, ductwork, or equipment in congested arrangements.
 - 7. Exterior underground lines.
 - 8. Locate, identify, and protect electrical services passing through remodeling or demolition area and serving other areas required to be maintained operational. When transit services must be interrupted, provide temporary services for the affected areas and notify the Owner prior to changeover.
- C. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls and other structural components as they are constructed.
- D. 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."
- E. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

1.05 QUALITY ASSURANCE

- A. Responsibility Prior to Submitting Pricing or Bid Data:
 - 1. Thoroughly review the contract documents and specifications and visit the site prior to issuing bid. Resolve all reported deficiencies with the Engineer prior to awarding any subcontracts, ordering material, or starting any work.
- B. Qualifications:
 - 1. Only products of specified manufacturers, or approved equals as determined by the Engineer, are acceptable.
 - 2. Employ only workmen who are skilled in their trades.
- C. Compliance with Codes, Laws, and Ordinances:
 - 1. Conform to all requirements of the state, city and local codes, laws and ordinances and other regulations having jurisdiction over this installation.
 - 2. If there are any discrepancies between the codes and regulations and these specifications, the Engineer shall determine the method or equipment to be used.
 - 3. Inform the Engineer in writing, requesting a clarification at the time of the bidding, if any parts of the drawings or specifications are found not to comply with the codes or

- regulations. Submit a separate price to make the system comply if there is insufficient time for this procedure.
4. Inform the Engineer in writing requesting a clarification if there is any discrepancy between a manufacturer's recommendation and these specifications.
 5. Follow the current issue of NFPA 70 "National Electrical Code" if there are no local codes having jurisdiction.
- D. Utility Company Requirements:
1. Secure all applicable requirements from the private or public Utility Company.
 2. Comply with all Utility Company requirements for service equipment, installation, and metering.
 3. Make application for and pay for new electrical service equipment and installation. Coordinate schedule and requirements with the Owner and Utility Company.
- E. Examination of Drawings:
1. The drawings for the indicated work are diagrammatic, intended to convey the scope of the electrical work and to indicate the general arrangements and locations of equipment, wiring devices, etc., and the approximate sizes of equipment. Field verification of dimensions on plans is required. The actual conditions, including heights, lengths and orientation shall be the basis of the work.
 2. The architectural, structural, mechanical, and electrical drawings and specifications shall be considered as mutually explanatory and complementary. Any electrical work called for by one and not by the other shall be performed as though required by all. All sections and subsections of the Electrical work shall be governed by and subject to the general and supplementary conditions. Report any discrepancies in or between the drawings and specifications, or between the drawings and actual field conditions to the Engineer in sufficient time to issue an addendum for clarification.
 3. Determine the exact locations for equipment and rough-ins, and the exact routing of raceways.
 4. Do not scale drawings to determine equipment and system locations.
 5. Not all required components are shown on the documents, including junction boxes, pull boxes, conduit fittings, etc. Provide all components required for proper installation of the work.
 6. Any item either shown on the drawings or called for in the specifications shall be included in this contract.
 7. Determine quantities and quality of material and equipment required from the documents. Provide the more expensive or higher quality amount where discrepancies arise among drawings, schedules, or specifications.
- F. Electronic Media and Files:
1. Our standard contracts do not include releasing the Revit model. Do not volunteer the Revit model to anybody. Check with the project manager for more information; don't contradict our own contract language.
 2. Electronic media files of the contract drawings in AutoCAD or PDF format and copies of the specifications in PDF format may be requested.
 3. Complete and return a signed "Electronic File Transmittal" form provided by Introba upon request for electronic media.
 4. 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.
 5. 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.
 6. The drawings prepared by Introba for bidding purposes may not be used directly for raceway layout drawings or coordination drawings.

7. 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.
8. 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.

1.06 SEISMIC REQUIREMENTS

- A. Conform to requirements in Section 20 0800 "Seismic Protection" including required submittals described under Section 20 0800.

1.07 ROUGH-IN

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- B. Coordinate equipment rough-in requirements with Divisions 02 through 28.

1.08 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 or reviewed and will be returned to the submitter. Refer to "Submittal Register" for all required submissions of each specification section. All required submissions of that specification section are to be submitted for review in one all-inclusive submission. Any deviation from specified items is considered a substitution.
 1. Non-requirement of submittals, when so noted, is not to be construed as an allowance for substitutions and does not provide relief from full compliance with the contract documents.
 2. Any deviation from specified items is considered a substitution. 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 02 if the use of other than specified items is being proposed. Where not defined in Division 01, requests for substitutions shall be submitted no less than ten (10) working days prior to bid date. The submitter must pay the engineer for review of substitution requests. Charges for this substitution review will be calculated based on the Engineer's standard hourly rates, as defined in their contract with the Owner.
- B. Definitions:
 1. Product Data: Pre-printed manufacturer's data.
 2. Shop Drawings: Drawings made specifically for the manufacture of a particular piece of equipment to be used on this project.
 3. Operation and Maintenance Data: Information containing instructions on the proper operation, maintenance, and repair of the equipment, complete with written text, diagrams, photos, exploded views and parts lists.
 4. Record Documents: Information indicating the actual installed conditions of the project on Mylar, electronic media, photographs, or typed paper. Photographs are not allowed as a substitute for correcting the construction documents; the photographs are for the Owner's future reference. Submit type, quantities and on media specified where indicated to be submitted.
- C. Where more than one model is shown on a manufacturer's sheet, clearly indicate exactly which item and which data is relevant to the work.
- D. Where the manufacturer lists multiple part numbers or options on a single data sheet, the part number and options to be used shall be clearly set apart from other part numbers shown on that sheet.
- E. 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. The Contractor's approval stamp is required on all submittals before submittal to the

Engineer. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Clearly mark all deviations from the contract documents on all submittals. The item shall be required to meet all drawing and specification requirements if deviations are not clearly marked.

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. Partial or incomplete submissions will be rejected.
 2. The Engineer shall not be responsible for informing the submitter 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 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 shall review each submittal no more than two times and return to the submitter with the appropriate disposition.
 5. If the Engineer is required to review a submittal a second time, it will be limited to review of the changed information, which must clearly be highlighted by the submitter. The submittal will be returned to the submitter 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 submitter. Charges for this additional submittal review will be calculated based on the Engineer's standard hourly rates, as defined in their contract with the Owner.
- F. 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. Ensure that the O&M submittal has been reviewed and includes all the requirements of the specifications. Submit only the data requested under the submittals portion of each specification section. FAX or photocopies are not allowed as submittals for operating and maintenance manuals. The Engineer will review the submittal for the Operation and Maintenance Manual one time and return to the submitter 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 submitter. Charges for this additional submittal review will 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. Photocopies of marked up Operations and Maintenance submittals are not acceptable.
- G. Coordination Drawings: Prepare and submit Coordination Drawings as further described herein and as indicated in the Special Conditions. Provide the Engineer with one copy of all coordination drawings supplied to the Owner when required in this specification. 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.
- H. Refer to Division 01 and each individual Division 26 & 28 Section for additional submittal requirements.

1.09 PRODUCT OPTIONS AND MATERIAL SUBSTITUTIONS

- A. Where two or more materials are listed in the "Part 2 – Products" subsection of any Division 26, 27 or 28 section, do not assume that the selection of materials is an option. Refer to "Part 3 – Execution" subsection of that same specification 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 conductors, and Part 3 will describe which type and grade of conductors to use for a given application.
- B. When two or more items of same material or equipment are required, they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials,

wire, conduit, fittings, sheet metal, steel bar stock, welding rods, solder, fasteners, motors for dissimilar equipment units, and similar items used in Work except as otherwise indicated.

- C. Provide products which are compatible within systems and other connected items.
- D. Substitutions: Products other than those specified must be submitted, approved, and secured in writing from the Engineer via Addendum. If requested, a sample of the proposed substitution must be submitted to the Engineer for evaluation. This sample shall be supplied at no cost to the Engineer, and will be returned to the submitter, at the submitter's expense at the end of the evaluation period.
- E. Where several manufacturers' names are given, the manufacturer for which a catalog number is given is the basis of design and establishes the quality required.
- F. Any material, article or equipment of other unnamed manufactures which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Engineer via Addendum. Assume all costs incurred as a result of using the offered material, article or equipment, including the part of other Divisions whose work is affected.
- G. Voluntary add or deduct prices for alternate materials may be listed on the bid form. These items will not be used in determining the low bidder. Assume all costs incurred as a result of using the offered material or equipment on his part or on the part of other Divisions whose work is affected.
- H. All material substitutions requested after the final Addendum must be listed as voluntary changes on the bid form.

1.10 PRODUCT, DELIVERY, STORAGE, HANDLING AND MAINTENANCE

- A. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage and handling. Protect stored equipment and materials from damage.
- B. Coordinate deliveries of electrical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations. Review the site prior to bid for path locations and any required building modifications to allow movement of equipment.
- C. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage.
- D. Keep all materials clean, dry and free from damaging environments.

1.11 MISCELLANEOUS MATERIALS

- A. Miscellaneous Materials Include:
 - 1. Miscellaneous metals for support of electrical materials and equipment.
 - 2. Wood grounds, nailers, blocking, fasteners, and anchorage for support of electrical materials and equipment.
 - 3. Concrete bases for equipment.
 - 4. Sealers for sealing around electrical materials and equipment; and for sealing penetrations in floors and walls.
 - 5. Access panels and doors in walls, ceilings, and floors for access to electrical materials and equipment.

1.12 WARRANTIES

- A. Refer to the Division 01 "Closeout Procedures" for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements.

- B. Compile and assemble the warranties specified in Divisions 26, 27 and 28 into a separated set of vinyl covered, three-ring binders, tabulated and indexed for easy reference.
- C. Provide complete warranty information for each item to include product or equipment, date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, telephone numbers and procedures for filing a claim and obtaining warranty services.
- D. Warranty requires correction of all work found to be defective or nonconforming to the Contract Documents, without cost to the Owner. Bear all costs associated with corrective measures and damage due to defects or nonconformance with the Contract Documents, excluding repairs required as a result of improper maintenance or operation, or normal wear and tear as determined by the Engineer.

PART 2 - PRODUCTS

2.01 MISCELLANEOUS LUMBER

- A. All lumber shall be fire-treated.
- B. Framing Materials: Standard Grade, light-framing-size lumber of any species. Number 3 Common or Standard Grade boards complying with WCLIB or AWPA rules, or Number 3 boards complying with SPIB rules. Lumber shall be preservative-treated in accordance with AWPB LP-2, and kiln-dried to a moisture content of not more than 19 percent.

2.02 ACCESS DOORS

- A. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
- B. Frames: 16-gage steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile or wood paneling.
- C. For Installation in Masonry, Concrete, Ceramic Tile, or Wood Paneling: 1 inch-wide-exposed perimeter flange and adjustable metal masonry anchors.
- D. For Gypsum Wallboard or Plaster: Perforated flanges with wallboard bead.
- E. For Full-Bed Plaster Applications: Galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.
- F. Flush Panel Doors: 14-gage sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
- G. Fire-Rated Units: Insulated flush panel doors with continuous piano hinge and self-closing mechanism.
- H. Locking Devices: Flush, screwdriver-operated cam locks.
- I. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Bar-Co., Inc.
 - 2. J.L. Industries.
 - 3. Karp Associates, Inc.
 - 4. Milcor Div. Inryco, Inc.
 - 5. Nystrom, Inc.

2.03 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Sleeves for Rectangular Openings: Galvanized sheet steel.
 - 1. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).

- b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).
 2. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.04 SLEEVE SEALS

- 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. GPT Link-Seal
 - d. Metraflex Co.
 - e. Pipeline Seal and Insulator, Inc.
 2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 3. Pressure Plates: Plastic. Include two for each sealing element.
 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.
 5. Place head end of bolts on accessible side of wall to allow for future adjustments.

2.05 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time and recommended for interior and exterior applications.

PART 3 - EXECUTION

3.01 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-mounted 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. Jobsite Safety: The Contractor is the sole entity responsible for jobsite safety.

3.02 EXAMINATION

- A. Examine substrates, areas, and conditions, with installer present, for compliance with requirements for installation tolerances and other conditions affecting installation and application of sealants and access panels. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Install equipment and materials in accordance with manufacturer instructions and the requirements in Section 20 0800 "Seismic Protection."

3.03 ROUGH-IN

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- B. Coordinate equipment rough-in requirements with Divisions 01 through 28.

3.04 ELECTRICAL INSTALLATIONS

- A. Coordinate electrical equipment and materials installation with other building components.
- B. Verify all dimensions by field measurements.
- C. Arrange for chases, slots, and openings in other building components to allow for electrical installations.
- D. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components as they are constructed.
- E. Sequence, coordinate and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing-in the building.
- F. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
- G. Install systems, materials and equipment to conform to project requirements and 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 Engineer.
- H. Systems, materials and equipment which will be exposed in finished areas shall be installed level and plumb, parallel and perpendicular to other building systems and components.
- I. Install electrical services and overhead equipment to provide the maximum headroom possible where mounting heights are not detailed or dimensioned.
- J. Install electrical equipment to facilitate maintenance and repair or replacement of equipment components. Maintain code clearances in front of and about all electrical equipment. As much as practical, connect equipment for ease of disconnecting with minimum of interference with other installations.
- K. Coordinate the installation of electrical materials and equipment above ceilings with suspension system, mechanical equipment and systems and structural components.
- L. Include in the Work all labor, materials, equipment, services, apparatus, and drawings (in addition to the Contract Documents) as required to complete the intended Work.
- M. Control and interlock wiring shall be installed in a separate raceway and shall not be installed in the same raceway as power conductors.
- N. Only new, clean and perfect equipment, apparatus, materials and supplies of latest design and manufacture shall be incorporated in the Work in order to assure an electrical system of high quality.
- O. The Work required in order to obtain utility services such as telephone and electric, is delineated in these specifications and on the drawings. Unless otherwise noted, construction or connection charges (except for temporary power) by those companies shall be paid by the Owner.
- P. Determine electrical utility elevations prior to installation and coordinate with other trades. Installation priorities at a minimum shall be as follows:
 - 1. Luminaires.
 - 2. Gravity flow piping, including steam and condensate.

3. Electrical bus duct.
4. Sheet metal.
5. Cable trays, including access space.
6. Other piping.
7. Conduits and wireway.

3.05 CONNECTIONS TO EQUIPMENT AND APPLIANCES

- A. In many instances the drawings show an outlet box and power supply for specific equipment, be it Owner- or Contractor-furnished. It is to be understood, unless otherwise noted, that the Work includes a connection from the box to the equipment or appliance. Verify circuit conductor quantities and sizes and overcurrent device number of poles and rating as well as any special grounding requirements, for all Owner-furnished equipment and adjust the required work accordingly.
- B. Owner Furnished Equipment:
 1. Install and connect Owner-supplied items electrical items indicated on Architectural Equipment Plans and Schedules even if not shown on the electrical plans. Connect all Owner-supplied items requiring electrical connections, whether or not shown on the electrical plans. Make all electrical system connections required for fully functional units.
 2. The Owner will supply manufacturer's installation data for new equipment purchased by owner for this project.
 3. Repair all damage to Owner-furnished equipment caused during installation, to the satisfaction of the Owner.

3.06 CUTTING AND PATCHING

- A. General: Perform cutting and patching in accordance with Division 01 Section "Execution." In addition to the requirements specified in Division 01, the following requirements apply:
 1. Perform cutting, fitting, and patching of electrical equipment and materials required to:
 - a. Uncover Work to provide for installation of ill-timed Work.
 - b. Remove and replace defective Work.
 - c. Remove and replace Work not conforming to requirements of the Contract Documents.
 - d. Remove samples of installed Work as specified for testing.
 - e. Install equipment and materials in existing structures.
 - f. Cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated, including but not limited to, removal of electrical items indicated to be removed and items made obsolete by the new Work.
 2. Coordinate the cutting and patching of building components to accommodate the installation of electrical equipment and materials.
 - a. Protect the structure, furnishings, finishes and adjacent materials not indicated or scheduled to be removed.
 - b. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

3.07 CONCRETE BASES

- A. Provide concrete bases for all floor-mounted electrical equipment, except that stand alone dry type transformers with integral floor channels may be placed without equipment bases when located in finished areas and electrical closets.
- B. Form concrete equipment bases using nominal 2 inch by 4-inch framing lumber (use larger framing if larger pads, such as for engine-generators are required) with form release compounds. Locate as indicated and construct 4 inches larger in both directions than supported unit. Except where otherwise indicated, pour bases 4 inches higher than surrounding slab. Anchor or key to floor slab in accordance with Section 20 0800 "Seismic Protection." Chamfer top edges and corners.

- C. Include all concrete materials and workmanship required for the electrical work. Materials and workmanship shall conform to the applicable standards of the Portland cement Association. Reinforce with 6-inch x 6-inch, W1.4-W1.4 welded wire fabric. Concrete shall withstand 3,000 pounds compression per square inch at twenty-eight days.
- D. Where the base is less than 12-inches from a wall, the base shall be carried to the wall to prevent a "dirt-trap."
- E. Place concrete and allow to cure before installation of equipment.

3.08 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment and elevation to support and anchor electrical materials and equipment.
- B. Field Welding: Comply with AWS "Structural Welding Code."

3.09 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.10 APPLICATION OF SEALERS

- A. General: Comply with sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
 - 1. Comply with recommendations of ASTM C 962 for use of elastomeric sealants.
- B. Tooling: Immediately after sealant application and prior to time shinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

3.11 INSTALLATION OF ACCESS DOORS

- A. Set frames accurately in position and securely attached to supports with face panels plumb and level in relation to adjacent finish surfaces.
- B. Adjust hardware and panels after installation for proper operation.

3.12 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Contract shall X-ray concrete slabs and walls prior to core drilling to avoid damage to utilities or reinforced steel.
- D. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- F. Cut sleeves to length for mounting flush with both surfaces of walls.
- G. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.

- H. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable, unless indicated otherwise.
- I. Seal space outside of sleeves with grout for penetrations of concrete and masonry
 - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
- K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."
- L. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- M. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- N. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.13 SLEEVE-SEAL INSTALLATION

- A. Use 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.
- B. Install to seal exterior wall penetrations.
- C. Install in concrete slabs and walls and all other fire-rated floors and walls for raceways and cable installations. Provide insulated bushings at each end of sleeve. For sleeves through fire rated-wall or floor construction, apply UL-listed firestopping sealant in gaps between sleeves and enclosed conduits and cables.
 - 1. Conduit Seals: Install seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.

3.14 FIRESTOPPING

- A. Apply rated firestopping sealants at all penetrations of fire and smoke walls; at all penetrations of floors and at other locations as noted on the drawings or where required by Code. Consider walls that are common to different abutting buildings, to different additions to buildings, and to fire and smoke separations within buildings as requiring firestopping sealant. Refer to architectural drawings. For existing buildings where fire separations are not noted on any drawings, use reasonable logic as to which separations are fire-rated. When in doubt, consult with Engineer or Architect.
- B. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.15 PAINTING

- A. Paint all electrical equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available. All equipment shall have a finished coat of paint applied unless specifically allowed to be provided with a prime coat only.

- B. Paint panelboard covers and covers of flush-mounted pull and junction boxes to match the room finish.
- C. Equipment in occupied spaces, or if standard to the unit, shall have a baked primer with based enamel finish coat free from scratches, abrasions, chipping, etc. Verify color preference with the Engineer before ordering equipment if a color option is specified.
- D. Paint all equipment in unfinished areas such as boiler room, mechanical spaces, and storage rooms. Equipment furnished with a suitable factory finish need not be painted.

3.16 ADJUST AND CLEAN

- A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project.
- B. Clean all foreign paint, grease, oil, dirt, labels, stickers, etc., from all equipment.
- C. Remove all rubbish, debris, etc., accumulated during construction from the premises.
- D. Refer to the Division 01 Section "Closeout Procedures" for general requirements for final cleaning.

3.17 SPECIAL REQUIREMENTS

- A. Coordinate the installation of all equipment, controls, devices, etc., with other trades to maintain clear access area for servicing.
- B. Install all equipment to maximize access to parts needing service or maintenance. Review the final location, placement, and orientation of equipment with the Owner's representative prior to setting equipment.
- C. Include removal and reinstallation of equipment and devices if they were installed without regard to coordination of access requirements and without previous confirmation with the Owner's representative.

3.18 SYSTEM COMMISSIONING

- A. The electrical systems shall be complete and operating. Include system start-up, testing, balancing and satisfactory system performance. This includes all calibration and adjustment of electrical controls, balancing of loads, troubleshooting and verification of software, and final adjustments that may be needed.
- B. All operating conditions and control sequences shall be tested during the start-up period. Testing all interlocks, safety shut downs, controls, and alarms.
 - 1. Utilize only skilled technicians to ensure that all systems perform properly. Reimburse the Owner on a time and materials basis for services rendered at the Engineer's standard hourly rates in effect when the services are requested if the Engineer is requested to visit the job site for troubleshooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation, workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design. Pay the Owner for services required that are project-, installation- or workmanship-related. Payment is due within 30 days after services are rendered.

3.19 FIELD QUALITY CONTROL

- A. General:
 - 1. All required equipment and systems tests shall be made during, and post-Construction as required.
 - 2. All required testing instruments, meters, etc., shall be provided.
 - 3. Technicians operating testing equipment shall be trained in testing procedures.
 - 4. Testing shall confirm that equipment and systems provided by the Contractor have been installed properly.

5. Unsatisfactory test results shall result in revisions or replacement of equipment or settings as required to provide a system capable of meeting test requirements. Tests shall be repeated, or additional tests made as necessary to confirm system capability as required by the Owner, Engineer or Authority Having Jurisdiction.

3.20 EXCAVATION, FILL, BACKFILL, COMPACTION, AND RESTORATION

A. General:

1. Prior to any excavation or digging, verify all underground utility locations. Contact all location services with sufficient time allowance for completion of utility location documentation.
2. Unless noted otherwise provide all excavation, fill, backfill, compaction and restoration required for the scope of work.

B. Excavation:

1. Excavations shall be made to proper dimensions and to accurate, solidate and undisturbed earth.
2. Provide all excavations that exceed the depth requirements with concrete of the same characteristics for foundations or compacted sand gravel fill. The type of fill shall be determined by the Engineer.
3. Do not damage surrounding structures, equipment, or buried pipe. Do not undermine footing or foundation.
4. Protect all excavations to prevent cave-ins and risk to workmen.
5. Saw-cut pavement or concrete surfaces where required for excavation with clean edges.
6. Notify Engineer if bearing soil is not found to be adequate and halt excavation operation until given direction from the Architect or Engineer.
7. Confirm the soil conditions at their own cost. Excavations shall be conducted as required in the documents.
8. A compacted bed of sand and gravel (minimum of 3 inches deep) shall be provided where trench is excavated in rock.

C. Dewatering:

1. All trenches and pits shall be kept free of accumulation of water. Provide all required equipment.

D. Underground Obstructions:

1. The electrical drawings do not necessarily show all underground piping, conduit, feeders, foundations, and other obstructions in the vicinity of the construction. Review the documents of all Divisions to determine other obstructions. Take applicable precautions in making installations near underground obstructions.
2. If objects not indicated on the drawings are encountered, remove, relocate or perform extra work as indicated by the Engineer.

E. Fill and Backfilling:

1. Furnish all necessary sand and material for backfilling. Waste material and garbage are not acceptable materials.
2. Remove excess excavated earth as directed.
3. Backfill materials shall be suitable for required compaction, clean and free of perishable materials, frozen earth, debris, earth with a high void content, and stones greater than 4 inches in diameter. Water is not permitted to remain in un-backfilled trenches.
4. All trenches and excavations shall be backfilled immediately after completion of conduit installation or forms removal unless otherwise noted.
5. Areas around piers, independent foundations or structures shall have backfilled on all sides to prevent displacement. Fill and backfill shall be spread uniformly.
6. All conduits that are not concrete encased shall be provided with a bed of a minimum of 3 inches depth of compacted sand. Backfill shall be provided with compacted layers above the conduits.

7. Provide sand backfill to grade for all conduits under slabs or paved areas. All other conduits shall have sand backfill to 6 inches above the top of the conduit.
 8. Backfill shall be made in layers of sand not exceeding 6 inches in depth.
 9. Protect surface to prevent loads from the top of the surface for a minimum of 48 hours after backfilling operation.
- F. Surface Restoration:
1. Areas shall be restored to the original condition, including areas that are landscaped. Replace all planting and landscaping features removed or damaged to its original condition. At least 6 inches of topsoil shall be applied where disturbed areas are to be seeded or sodded. All lawn areas shall be sodded unless seeding is called out in the drawings or specifications.
 2. Concrete or asphalt type pavement and other surfaces removed or damaged shall be replaced to original condition. Broken edges shall be saw cut and repaired as directed by Architect or Engineer.

3.21 OPERATION AND MAINTENANCE DATA

- A. Refer to the Division 01 Section: "Closeout Procedures" for procedures and requirements for preparation and submittal of maintenance manuals.
- B. In addition to the information required by Division 01 for Maintenance Data, include the following information:
 1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
 2. Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions, regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
 3. Maintenance procedures for routine preventive maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
 4. Servicing instructions and lubrication charts and schedules.
- C. Submit three (3) properly indexed and bound copies in "D" ring style notebooks, of the Operations and Maintenance Instructions to the Architect or Engineer. Make all corrections or additions required.
- D. Operation and Maintenance Instructions shall include:
 1. Notebooks shall be heavy duty locking three-ring binders, black in color, and incorporate clear vinyl sheet sleeves on the front cover and spine for slip-in labeling. "Peel and stick" labels are not acceptable. Sheet lifters shall be supplied at the front of each notebook. Size notebooks a minimum of 1/2 inch thicker than the material for future inserts. Label the spine and front cover of each notebook. If more than one notebook is required, label in consecutive order. For example; 1 of 2, 2 of 2. No other forms of binding will be acceptable.
 2. Prepare binder covers (front and spine) with printed title "Operation and Maintenance Instructions," title of project, and subject matter of binder when multiple binders are required.
 3. Title page with project title, Architect, Engineer, Contractor, and Subcontractor with addresses, telephone numbers, and contacts.
 4. Table of Contents describing all index tabs.
 5. Listing of all Subcontractors and major equipment suppliers with addresses, telephone numbers and contacts.
 6. Index tabs dividing information by specification section, major equipment, or systems. All tab titles shall be clearly printed under reinforced plastic tabs. Label all equipment to match the identification in the construction documents.
 7. Copies of warranties.

8. Copies of all final approved shop drawings and submittals. Copy of power system study and overcurrent protective device settings.
 9. Copies of all factory inspections and or equipment start-up reports.
 10. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
 11. Dimensional drawings of equipment.
 12. Detailed parts lists, each with a list of suppliers.
 13. Operating procedures for each system.
 14. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
 15. Repair procedures for major components.
 16. Replacement parts and service material requirements for each system and the frequency of service required.
 17. Instruction books, cards, and manuals furnished with the equipment.
- E. Operation and maintenance data shall consist of written instructions for the care, maintenance, and operation of the equipment and systems. Instruction books, cards, manuals furnished with the equipment shall be included.
- F. In addition to the information required by Division 01 for Maintenance Data, include the following information:
1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
 2. Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions, regulation, control, stopping, shut-down, and emergency instructions; and summer and winter operating instructions.
 3. Maintenance procedures for routine preventive maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
 4. Servicing instructions and lubrication charts and schedules.
- G. Adequately instruct the Owner's designated representative in the maintenance, care, and operation of the complete systems installed under this contract.
- H. Provide verbal and written instructions to the Owner's representatives by factory personnel in the care, maintenance and operation of the equipment and systems.
- I. Digitally record training and provide the video file in MP4 format to the Owner. Coordinate training videos with operation and maintenance manuals and classroom instruction for use by the Owner in operating, maintaining, and troubleshooting. The Owner shall have the right to make additional copies of the training video for internal use without paying royalties.
- J. The instructions shall include:
1. Maintenance of equipment.
 2. Start-up procedures for all major equipment.
 3. Description of emergency system operation.
- K. Notify the Engineer of the time and place for the verbal instructions to the Owner's representative so his representative can be present if desired.
- L. Minimum hours of instruction time for each item and/or system shall be as indicted in each individual specification section.
- M. Operating Instructions:
1. Include instructions to the Owner's representatives for the electrical and specialized systems, using factory-authorized technical representatives.

3.22 RECORD DOCUMENTS

- A. Prepare record documents in accordance with the requirements in Division 01 Section "Closeout Procedures." In addition to the requirements specified in Division 01, indicate installed conditions for:
 - 1. Raceways of 2-inches and larger, indicating size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
 - 2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
 - 3. Location of every home run point, such as receptacle, lighting fixture, or switch.
 - 4. Approved substitutions, Contract modifications, and actual equipment and materials installed.
 - 5. Mark Drawings to indicate revisions to conduit size and location both exterior and interior; actual equipment locations, dimensioned from column lines; concealed equipment, dimensioned to column lines; distribution and branch electrical circuitry; fuse and circuit breaker size and arrangements; support and hanger details; change orders; concealed control system devices.
 - 6. Mark Specifications to indicate approved substitutions, change orders, actual equipment and materials used.
- B. Maintain at the job site a separate and complete set of electrical drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.
- C. Mark Drawings to indicate revisions to conduit size and location both exterior and interior; actual equipment locations, dimensioned from column lines; concealed equipment, dimensioned to column lines; distribution and branch electrical circuitry; fuse and circuit breaker size and arrangements; support and hanger details; Change Orders; concealed control system devices.
- D. Mark drawings and specifications to indicate approved substitutions; Change Orders, and actual equipment and materials used. Mark all Change Orders, RFI responses, clarifications, and other supplemental instructions on the documents. Record documents that merely reference the existence of the above items are not acceptable. Reimburse the Engineer for all costs for the Engineer to develop record documents which comply with this requirement if unable to comply with said above requirements. Reimbursement shall be made at the Architect or Engineer's hourly rates in effect at the time of the work.
- E. Record changes daily and keep the marked drawings available for the Architect or Engineer's examination at any normal work time.
- F. Upon completing the job, and before final payment is made, give the marked-up drawings to the Engineer.

3.23 PROJECT CLOSEOUT

- A. The following paragraphs supplement the requirements of Division 01:
- B. Final Jobsite Observation:
 - 1. Certify that the project jobsite is ready for the final jobsite observation.
 - 2. Reimburse the Engineer, based on the Engineer's standard hourly rates as defined in their contract with the Owner, for additional time and expenses when additional trips are required because the project jobsite was not ready for final observation and additional trips are required by the Engineer for review of final conditions.
 - 3. Notify the Engineer a minimum of two working days prior to installation of ceiling tiles or lay-in ceilings to allow the Engineer to visit the project site.
- C. Submit the following documents to the Architect or Engineer prior to requesting final payment:
 - 1. Operation and maintenance manuals with copies of approved shop drawings.
 - 2. Record documents including electronic AutoCAD or REVIT drawings and specifications.
 - 3. Documentation of completion of all required training of Owner's personnel.

4. Provide spare parts, maintenance and extra materials in quantities specified in individual specification sections.
5. Inspection and testing reports.
6. Start-up reports on all equipment requiring a factory installation or start-up.
7. Submittals required by commissioning of the electrical systems.

END OF SECTION

SECTION 26 0519
CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Conductors and Cables.
 - 2. Remote Control and Signal Cable.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Conductors and Cables.
 - 2. Remote Control and Signal Cable.

1.04 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. Comply with NFPA 70 "National Electrical Code."
 - 1. Conform to applicable codes and regulations regarding toxicity of combustion products of insulating materials.
- C. UL Compliance: Provide components which are listed and labeled by Underwriters Laboratories under the following standards.
 - 1. UL Std. 83 Thermoplastic-Insulated Wires and Cables.
 - 2. UL Std. 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors.
- D. NEMA and ICEA Compliance: Provide components which comply with the following standards:
 - 1. WC-70: Power Cables Rated 2,000V or Less for the Distribution of Electrical Energy.
- E. IEEE Compliance: Provide components which comply with the following standard.
 - 1. Std. 82: Test procedures for Impulse Voltage Tests on Insulated Conductors.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. ***OR***
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. American Insulated Wire Corp.; a Leviton Company.
 - 2. General Cable Corporation.
 - 3. Senator Wire & Cable Company.
 - 4. Southwire Company.
 - 5. Cerro Wire.
 - 6. Superior Essex.
 - 7. Encore Wire Corporation.
- C. University of Missouri does not permit aluminum conductors.
- D. Copper Conductors: Comply with NEMA WC 70.
- E. Conductor Insulation: Comply with NEMA WC 70 for Types THW, THHN-THWN, XHHW.

2.02 CONDUCTORS AND CABLES

- A. General: Provide wire and cable suitable for the temperature, conditions, and location where installed.
- B. University of Missouri does not permit aluminum conductors.
- C. Feeders: Copper, 600-volt insulation. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- D. Branch Circuits: Copper, 600-volt insulation. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- E. Control Circuits: Copper, stranded conductor, 600-volt insulation.
- F. Wire for the following specialized systems shall be as shown on drawings or as dictated within these specifications. Where not designated, the systems manufacturer's recommendations shall be adhered to for the following systems:
 - 1. Fire Alarm.
 - 2. Low Voltage Switching.
 - 3. Sound.
 - 4. Electronic Control.
 - 5. Data.
 - 6. Telephone.
 - 7. Security.
 - 8. TV.
 - 9. Clock.
 - 10. Nurse Call.
- G. Single Conductors for Feeders and Branch Circuits:
 - 1. Stranding: Provide solid conductors for branch circuits and non-vibrating power utilization equipment utilizing Number 10 AWG and smaller. Provide stranded conductors for Number 8 AWG and larger. Provide stranded conductors, regardless of size, for connections to vibrating equipment such as motors and transformers.
 - 2. Retain the following paragraph where hospital isolated power panels are used (X-Ray, Operating Rooms, etc.).

2.03 REMOTE CONTROL AND SIGNAL CABLE

- A. Control Cable for Class 1 Remote Control and Signal Circuits: Copper conductor, 600-volt insulation, rated 60 degrees C, individual conductors twisted together, shielded, and covered with a PVC jacket.
- B. Control Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300-volt insulation, rated 60 degrees C, individual conductors twisted together, shielded, and covered with a PVC jacket; UL listed.
- C. Plenum Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300-volt insulation, rated 60 degrees C, individual conductors twisted together, shielded and covered with a nonmetallic jacket; UL listed for use in air handling ducts, hollow spaces used as ducts, and plenums.

2.04 CONNECTORS AND SPLICES

- 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. 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.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type and class for application and service required.

PART 3 - EXECUTION

3.01 CONDUCTOR INSULATION, APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN-THWN, single conductors in raceway.
- B. Concealed in Ceilings, Walls, Partitions, Raised Flooring and Crawlspace: Type THHN-THWN, single conductors in raceway.
- C. Concealed in Concrete, below Slabs-on-Grade and Underground: Type THWN, single conductors in raceway.
- D. Exposed, Including in Crawlspace: Type THHN-THWN, single conductors in raceway.
- E. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- F. Class 1 Control Circuits: Install per NEC Article 725.
- G. Class 2 Control Circuits: Install per NEC Article 725.

3.02 DEVIATION FROM CONTRACT DRAWINGS

- A. Basis of Design is copper conductors installed in raceway, based on 30 degrees C ambient temperature (NEC Table 310.15(B)(16)). If materials or methods selected for installation differ from the basis of design, size conductors and conduits to meet or exceed the ampacity of circuits selected for the basis of design.
- B. Routing multiple conductors within a single conduit requires the conductor ampacity to be derated per National Electrical Code Article 310. Do not provide more than 4 conductors within a single conduit to serve loads such as panelboards, motor control centers, motors over 1/4 horsepower, etc.

3.03 INSTALLATION OF CONDUCTORS AND CABLES

- A. Install products in accordance with manufacturer's instructions.
- B. Conceal cables in finished walls, ceilings and floors unless otherwise indicated.
- C. Completely and thoroughly swab raceway before installing wire.
- 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 and cable grips which will not damage cables or raceways. Do not use rope hitches for pulling attachment to wire or cable. Do not exceed maximum tensile strength of conductor or grip. Do not exceed maximum sidewall pressure limitations of cables.
- F. Pull conductors simultaneously where more than one is being installed in the same raceway.
- G. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
- H. Feeder conductors shall be continuous and shall not contain splices.
- I. Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than Number 10 AWG cabled in individual circuits. Make terminations so there is no more than 1/8 inch of exposed bare conductor at the terminal. Observe NEC 310.15 (B)(2)(a) adjustment factors.

- J. Verify that interior of building has been protected from weather and mechanical work likely to damage wire and cable has been completed prior to installing wire and cable.
- K. Use conductor not smaller than Number 12 AWG for power and lighting circuits.
- L. Single conductors used for control circuits shall not be smaller than Number 14 AWG.
- M. Use Number 10 AWG conductors (phase, neutral and ground) for 20 ampere, 120-volt branch circuits longer than 75 feet, unless drawings requirements are more stringent.
- N. Use Number 10 AWG conductors (phase, neutral and ground) for 20 ampere, 277-volt branch circuits longer than 200 feet, unless drawings requirements are more stringent.
- O. Place an equal number of conductors for each phase, neutral and ground of a circuit within the same raceway or cable when routing parallel conductors. Conductor lengths must be equal.
- P. Support cables according to Division 26 Section "Hangers and Supports."
- Q. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

3.04 CABLE INSTALLATION, APPLICATIONS AND WIRING METHODS

- A. Open cabling shall be routed in a symmetrical manner, tight and parallel to walls.
- B. Support open cable by appropriate size bridle rings or j-hooks at five-foot intervals. Open cable may not rest on suspended ceilings. Wire and cable from different systems shall not be installed within the same bridle rings or j-hooks. Neatly bundle grouped cables every two-and-a-half feet with a nylon tie wrap.
- C. Open cable may only be installed where specifically dictated on drawings or permitted elsewhere within these specifications.

3.05 CONNECTIONS AND TERMINATIONS

- A. Include reference to UL 486B if aluminum conductors are allowed.
- B. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A.
- C. Clean conductor surfaces before installing lugs and connectors.
- D. Utilize solderless compression terminals applied with circumferential compression for conductor sizes 8 AWG and larger and crimp in accordance with manufacturer instructions. Indenter compression method may be used for conductor sizes 10 AWG and smaller.
- E. Phase Sequence: Connections to phase conductors at electrical equipment shall be made such that the A-B-C conductors, when facing the equipment, are oriented top to bottom, or left to right.
- F. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

3.06 SPLICES AND TAPS

- A. Conductor splices shall be kept to a minimum.
- B. Only splice within accessible junction boxes or enclosures.
- C. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors. Splices and taps shall be capable of carrying the full ampacity of the conductors without perceptible temperature rise.
- D. Above Grade:
 - 1. Use copper compression connectors applied with circumferential compression for conductor sizes 6 AWG and larger.

2. Use pre-molded insulated tap connectors for copper conductor splices and taps, Number 8 AWG and smaller. Insulate with UL listed insulating cover supplied by same manufacturer as connector.
 3. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, Number 10 AWG and smaller.
 4. Tape uninsulated conductors and connectors with electrical tape to 150 percent of insulation rating of conductor, or three layers of tape, whichever is greater.
- E. Below Grade:
1. Use specified insulated connectors suitable and approved for below grade wiring connectors. Ensure that conductors do not apply tension to splice.

3.07 FIELD QUALITY CONTROL

- A. Inspect wire for physical damage and proper connection.
- B. Measure tightness of bolted connections with properly scaled and calibrated torque tool and compare torque measurements with manufacturer's recommended values.
- C. Before energizing, test wires and cables for electrical continuity and for short circuits.
- D. Remove and replace malfunctioning conductors and retest as specified above.

END OF SECTION

THISPAGELEFT INTENTIONALLY BLANK

SECTION 26 0526
GROUNDING AND BONDING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes solid grounding of electrical systems and equipment. It includes basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented in other sections of these Specifications.

1.03 SUBMITTALS

- A. Submittals for approval by the Engineer of products to be used are not required for this section. Unrequested submittals will not be processed or reviewed. Non-requirement of submittals is not to be construed as an allowance for substitutions and does not allow relief from full compliance with the contract documents.
- B. Field Test Reports: Submit written test reports to include the following:
 - 1. Test procedures used.
 - 2. Weather and soil conditions observed on test date.
 - 3. Test results that comply with requirements.
 - 4. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.04 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.
- C. Listing and Labeling: Provide products specified in this Section that are listed and labeled for the specific purposes by Underwriters Laboratories.
- D. Testing Agency Qualifications: Member Company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.01 GROUNDING AND BONDING PRODUCTS

- A. Products: Of types indicated and of sizes and ratings to comply with NEC. Where types, sizes, ratings, and quantities indicated are in excess of NEC requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.

2.02 CONDUCTORS

- A. General: Comply with Division 26 Section "Conductors and Cables" for insulated grounding conductors. Conform to NEC Table 8, except as otherwise indicated, for conductor properties, including stranding.
- B. Equipment Grounding Conductor: Green insulated; conductor metal shall match branch circuit conductor metal.
- C. Grounding Electrode Conductor: Stranded cable.
- D. Underground Conductors: Bare, stranded copper except as otherwise indicated.
- E. Copper Conductors: Conform to the following:

1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
2. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
3. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
4. Bonding Strap Conductor/Connectors: Soft copper, 0.05 inch thick and 2 inches wide, except as indicated.

2.03 GROUNDING BUS

- A. Predrilled rectangular bars of annealed copper, 1/4-inch by 6 inches in cross section, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

2.04 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure (clamp) type with at least two bolts.
- C. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
- D. Pressure Connectors: High-conductivity-plated units.
- E. Bolted Clamps: Heavy-duty units listed for the application.
- F. Exothermic Welded Connections: Provided in kit form and selected for the specific types, sizes, and combinations of conductors and other items to be connected.
- G. Compression Connectors: Irreversible compression connectors must be factory filled with oxide inhibitor and fully crimped with a 14-ton or larger hydraulic tool so that index number is embossed on the connector. May be used above or below grade.

PART 3 - EXECUTION

3.01 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. Route grounding electrode conductors within rigid polyvinyl chloride (PVC) conduit.
- C. Seal all exterior wall penetrations airtight.

3.02 GROUNDING BUS

- A. 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 (50 mm) minimum from wall, 6 inches (150 mm) above finished floor unless otherwise indicated.
 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down to specified height above floor; connect to horizontal bus.

3.03 EQUIPMENT GROUNDING

- A. Equipment Grounding Conductor Application: Comply with NEC Article 250 for sizes and quantities of equipment grounding conductors, except where larger sizes or more conductors are indicated.
- B. Install separate insulated equipment grounding conductors with all feeders and branch circuit conductors. Terminate each end on a grounding lug or bus.

3.04 BONDING

- A. Air Duct Equipment Circuits: Install an insulated equipment grounding conductor to duct-mounted electrical devices operating at 120-V and above including air cleaners and heaters. Bond the conductor to each such unit and to the air duct.
- B. Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, pumps, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.
- C. Water Heater, Heat Tracing, and Anti-Frost Heater Circuits: Install separate insulated equipment ground conductor to each electric water heater, heat tracing and surface anti-frost heating cable. Bond this conductor to heater units, piping and connected equipment and components.
- D. Building Expansion Joints: Provide flexible bonding jumper between columns and beams on both sides of each expansion joint.
- E. Separately Derived Systems: Where the NEC requires separately derived systems to be grounded, provide grounding in accordance with the NEC.
- F. Connection to Other Systems: Bond electrical system grounding, lightning protection, telephone, CATV, other communications systems, metal water piping, metal gas piping and other piping systems together.
- G. 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-inch by-4-inch by-12-inch (6.3-by-100-by-300-mm) grounding bus.
 - 3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- H. Lightning Protection System Common Ground Bonding: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized the same as system grounding electrode conductor and install in conduit.
- I. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- J. Braided-Type Bonding Jumpers: Install to connect ground clamps on water meter piping to bypass water meters electrically. Use elsewhere for flexible bonding and grounding connections.

3.05 CONNECTIONS

- A. General: Select connectors, hardware and conductors and make connections in such a manner as to minimize possibility of galvanic action or electrolysis.
 - 1. Make connections with clean bare metal at points of contact.

2. Aluminum to steel connections shall be with stainless-steel separators and mechanical clamps.
 3. Aluminum to galvanized steel connections shall be with tin-plated copper jumpers and mechanical clamps.
 4. Coat and seal connections involving dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
 5. Exothermic Welded Connections or Compression-type Connections: Use for connections to structural steel and for underground connections except those at test wells. Install at connections to ground rods and plate electrodes. Comply with manufacturer's written recommendations. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable. Compression connections should be inspected for visible die index number matching the die and connector used. Connections that do not show this are not acceptable.
- B. Conductor Terminations and Connections:
1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 2. Connections to Structural Steel: Exothermic-welded or compression-type ground stud connector.
- C. Equipment Grounding Conductors: Terminate insulated equipment grounding conductors for feeders and branch circuits with pressure-type grounding lugs.
- D. Metallic Raceway Continuity: Where metallic raceways terminate at metallic housings without mechanical and electrical connection to the housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to the ground bus in the housing. Bond electrically non-continuous conduits at both entrances and exits with grounding bushings and bare grounding conductors.
- E. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A.
- F. Compression-Type Connections: Use hydraulic compression tools of at least 14-ton size to provide the correct circumferential pressure for compression connectors. Use tools and dies recommended by the manufacturer of the connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on the ground conductor.

3.06 FIELD QUALITY CONTROL

- A. Independent Testing Organization: Contractor shall arrange and pay for the services of a qualified independent electrical testing organization to perform tests described below.
- B. Tests and Inspections: After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements:
1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
 3. 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.

4. Maximum Ground Resistance Values:
 - a. Service neutral to reference ground: 5 Ohms
 - b. Equipment rated 500 kVA and Less: 10 Ohms.
 - c. Equipment rated 500 to 1000 kVA: 5 Ohms.
 - d. Equipment rated greater than 1000 kVA: 3 Ohms.
 - e. Substations and Pad-Mounted Equipment: 5 Ohms.
 - f. Manhole Grounds: 10 Ohms.
5. Where resistance to ground exceeds specified values, notify Engineer, and include recommendations to reduce ground resistance.

END OF SECTION

THISPAGELEFT INTENTIONALLY BLANK

**SECTION 26 0529
HANGERS AND SUPPORTS**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.
 - 2. Construction requirements for concrete bases.

1.03 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.
- D. RNC: Rigid non-metallic conduit.
- E. Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of four times the applied force.

1.04 SUBMITTALS

- A. Submittals for approval by the Engineer are not required for this section. Unrequested submittals will not be processed or reviewed. Non-requirement of submittals is not to be construed as an allowance for substitutions and does not allow relief from full compliance with the contract documents.

1.05 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Electrical components shall be listed and labeled for the specific intended purpose by Underwriters Laboratories, Inc.
- C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.06 COORDINATION

- A. Coordinate size, shape and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Slotted Metal Angle and U-Channel Systems:
 - a. Allied Tube & Conduit.
 - b. American Electric.
 - c. B-Line Systems, Inc.
 - d. GS Metals Corp.
 - e. Unistrut Diversified Products.
 - 2. Conduit Sealing Bushings:
 - a. Bridgeport Fittings, Inc.
 - b. Killark Electric Mfg. Co.
 - c. O-Z/Gedney.

- d. Raco, Inc.
- e. Red Seal Electric Corp.

2.02 COATINGS

- A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish or inherent material characteristic.

2.03 MANUFACTURED SUPPORTING DEVICES

- A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets and spring steel clamps.
- B. Fasteners: Types, materials and construction features as follows:
 - 1. Expansion Anchors: Carbon steel wedge or sleeve type.
 - 2. Toggle Bolts: All steel springhead type.
 - 3. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A 325.
- C. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps and cap screws.
- D. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.
- E. U-Channel Systems: 16-gauge steel channels, with 9/16-inch-diameter holes, between one and one half and two- and one-half inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.

2.04 FABRICATED SUPPORTING DEVICES

- A. General: Shop- or field-fabricated supports or manufactured supports assembled from U-channel components.
- B. Steel Brackets: Fabricated of angles, channels and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.
- C. Pipe Sleeves:
 - 1. Provide pipe sleeves of one of the following:
 - a. Interior Dry Locations: Fabricate from Schedule 40 galvanized steel pipe or Schedule 40 PVC plastic pipe.
 - b. Exterior or Interior Wet or Damp Locations: Fabricate from Schedule 40 PVC plastic pipe.
 - 2. Sleeves shall not penetrate structural members without approval from the Structural Engineer.
 - 3. Openings through unexcavated floors and/or foundation walls below the floor shall have a smooth finish with sufficient annular space around material passing through opening so slight settling will not place stress on the material or building structure.
 - 4. Install all sleeves concentric with conduits. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.
 - 5. Where conduits rise through concrete floors that are on earthen grade, provide 3/4-inch resilient expansion joint material (asphalt and cork) wrapped around the pipe, the full depth of concrete at the point of penetration. Secure to prevent shifting during concrete placement and finishing.
 - 6. Size sleeves large enough to allow expansion and contraction movement.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC requirements.
- B. Coordinate with the building structural system and with other disciplines' installations.
- C. Raceway Supports: Comply with the NEC and the following requirements:
 - 1. Conform to manufacturer's recommendations for selection and installation of supports.
 - 2. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 lbs, provide additional strength until there is a minimum of 200 pounds safety allowance in the strength of each support.
 - 3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
 - 4. Support parallel runs of horizontal raceways together on trapeze-type hangers.
 - 5. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-inch and smaller raceways serving branch circuits, telephone and data above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4-inch-diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.
 - 6. Space supports for raceways in accordance with Table I of this section. Space supports for raceway types not covered by the above in accordance with NEC.
 - 7. Support exposed and concealed raceway within 3 feet of boxes, access fittings, device boxes or cabinets.
 - 8. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway or conductor terminals.
 - 9. Vertical Conductor Supports: Install simultaneously with installation of conductors.
 - 10. Miscellaneous Supports: Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.
- D. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, motor control centers, disconnect switches and control components in accordance with the following:
 - 1. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.
 - 2. Holes cut to depth of more than 1-1/2 inches in reinforced concrete beams or to depth of more than 3/4-inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.
 - 3. Do not fasten supports to ceiling systems, piping, ductwork, mechanical equipment or conduit unless otherwise noted.
 - 4. Do not use powder-actuated anchors without specific permission.
 - 5. Do not drill structural steel members.
 - 6. Install surface-mounted cabinets and panelboards with minimum of four anchors.
 - 7. Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.

- E. In wet locations and on all building floors below exterior earth grade install freestanding electrical equipment on concrete pads.
- F. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration- and shock-resistant fasteners for attachments to concrete slabs.
 - 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.

3.02 PAINTING

- A. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

a. TABLE I: SPACING FOR RACEWAY SUPPORTS

Raceway Size (Inches)	No. of Conduits in Run	Location	Maximum Spacing of Supports (Feet)		
			RMC & IMC*	EMT	RNC
1) HORIZONTAL RUNS					
1/2, 3/4	1 or 2	Flat ceiling or wall.	5	5	3
1/2, 3/4	1 or 2	Where it is difficult to provide supports except at intervals fixed by the building construction.	7	7	--
1/2, 3/4, 1	3 or more	Any location.	7	7	--
1 & larger	1 or 2	Flat ceiling or wall.	6	6	--
1 & larger	1 or 2	Where it is difficult to provide supports except at intervals fixed by the building construction.	10	10	--
1 & larger	3 or more	Any location.	10	10	--
Any	--	Concealed.	10	10	--
2) VERTICAL RUNS					
1/2, 3/4	--	Exposed.	7	7	--
1, 1-1/4	--	Exposed.	8	8	--
1-1/2 and larger	--	Exposed.	10	10	--
Up to 2	--	Shaftway.	14	10	--
2-1/2	--	Shaftway.	16	10	--
3 & larger	--	Shaftway.	20	10	--
Any	--	Concealed.	10	10	--

*Maximum spacings for IMC above apply to straight runs only. Otherwise, the maximums for EMT apply.

END OF SECTION

THISPAGELEFT INTENTIONALLY BLANK

SECTION 26 0533
RACEWAYS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following raceways electrical wiring:
 - 1. Metallic Conduit and Tubing.
 - 2. Non-Metallic Conduit and Tubing.
 - 3. Metal Wireways.
 - 4. Non-Metallic Wireways.
 - 5. Surface Raceways.
 - 6. Low Voltage Cabling Support.
 - 7. Communications Raceway Accessories.

1.03 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

1.04 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. Comply with NFPA 70 "National Electrical Code" for components and installation.
- C. Comply with NECA "Standard of Installation."
- D. Listing and Labeling: Provide products specified in this Section that are listed and labeled by Underwriters Laboratories for the specific purpose and comply with the following standards:
 - 1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
 - 2. ANSI C80.3 - Electrical Metallic Tubing, Zinc Coated.
 - 3. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
 - 4. ANSI C80.6 – Intermediate Metal Conduit, Zinc Coated.
 - 5. ANSI/NFPA 70 - National Electrical Code.
 - 6. ANSI/NEMA FB 1 – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable.
 - 7. NECA "Standard of Installation."
 - 8. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
 - 9. NEMA TC 2 - Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).
 - 10. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.
 - 11. NEMA TC 6 - PVC and ABS Plastic Utilities Duct for Underground Installation.
 - 12. NEMA TC 9 – Fittings for PVC Plastic Utilities Duct for Underground Installation.
 - 13. NEMA TC 13 – Electrical Nonmetallic Tubing (ENT).
 - 14. NEMA TC 14 – Reinforced Thermosetting Resin Conduit (RTRC) and Fittings (fiberglass).
 - 15. TIA/EIA-569-A – Commercial Building Standard for Telecommunications pathways and spaces.
 - 16. TIA/EIA-606-A – The Administrative Standard for the Telecommunications Infrastructure of Commercial Buildings.

17. "Telecommunications Distribution Methods Manual" published by the Building Industry Consulting Services International (BICSI).

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Provide conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) for each service indicated. Where types and grades are not indicated, provide proper selection determined by installer to fulfill wiring requirements, and comply with applicable portions of NFPA 70 for raceways.
- B. Bushings: Bushings for terminating conduits smaller than 1-1/4 inches are to have flared bottom and ribbed sides, with smooth upper edges to prevent injury to cable insulation. Install insulated type bushings for terminating conduits 1-1/4 inches and larger. Upper edge to have phenolic insulating ring molded into bushing. Bushings to have screw type grounding terminal.
- C. Raintight Sealing Hubs: Two-piece type with outer internally-threaded hub to receive conduit, inner locking ring with bonding screw, insulated throat, and V-shaped ring or O-ring.

2.02 METAL CONDUIT AND TUBING

- A. Rigid Steel (Metallic) Conduit:
- Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - Allied Tube & Conduit.
 - LTV Steel Tubular Products Company.
 - O-Z Gedney.
 - Wheatland Tube Company.
 - Description: Conduit to be seamless, hot dipped galvanized rigid steel. Threads to be cut and ends chamfered prior to galvanizing. Galvanizing to provide zinc coating fused to inside and outside walls of conduit. Provide an enamel lubricating coating on the inside of the conduit. Conduit to conform to ANSI C80.1 and listed and labeled under UL 6.
 - Fittings and Conduit Bodies: Compression.
 - Joint Compound: Listed for use in cable connector assemblies and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.
- B. Electrical Metallic Tubing:
- Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - Allied Tube & Conduit.
 - Republic Conduit.
 - Wheatland Tube Company.
 - Description: Conduit to be seamless, hot dipped or electro-galvanized steel tubing. Galvanizing to provide zinc coating fused to outside walls of conduit. Provide an enamel lubricating coating on the inside of the conduit. Conduit to conform to ANSI C80.3 - 1983 and listed and labeled under UL 797.
 - Fittings and Conduit Bodies: Compression. Steel only. Cast or malleable iron is not acceptable.
 - Expansion fittings for use with EMT shall allow for a minimum of four inches of movement and shall be similar to O-Z Gedney TX series, complete with bonding jumpers and hardware.
- C. Flexible Metal Conduit: Zinc-coated steel or aluminum.
- Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - AFC Cable Systems.
 - Alflex Inc.

- c. Electri-Flex Co.
 2. Description: Interlocked steel or aluminum construction, consisting of spirally wrapped, convoluted hot dip galvanized steel strip. Zinc coating to cover both sides and all edges of steel strip. Convolutions to be interlocked to prevent separation when conduit is bent at radius equal to 4-1/2 times conduit O.D. Conduit to be listed and labeled under UL 1.
 3. Fittings: Compression.
- D. Liquidtight Flexible Metal Conduit:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AFC Cable Systems.
 - b. Alflex Inc.
 - c. Electri-Flex Co.
 2. Description: Flexible steel conduit with PVC jacket, listed and labeled under UL 360
 3. Fittings: and Conduit Bodies: Watertight, compression type, galvanized zinc coated cadmium plated malleable cast iron. Conduit to be listed and labeled under UL 360.

2.03 METAL WIREWAYS

- A. Available Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Cooper B-Line, Inc.
 2. Hoffman.
 3. Square D; Schneider Electric.
- B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, 12, or 3R as environmental conditions dictate, unless otherwise indicated.
- C. Material: Primed and painted sheet steel for indoor locations, galvanized sheet steel for outdoor locations sized as indicated or required, whichever is greater.
 1. Wireway up to 6 inch by 6-inch cross section shall be minimum 16 gage.
 2. Wireway larger than 6 inch by 6-inch cross section shall be minimum 14 gage.
- D. Fittings and Accessories: Include 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.
- E. Wireway Covers: Hinged or Screw-cover type. Utilize flanged-and-gasketed type for outdoor locations.
- F. Finish: Manufacturer's standard gray enamel finish.

2.04 SURFACE RACEWAYS

- A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish prime coating, ready for field painting.
 1. Available Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Thomas & Betts Corporation.
 - b. Walker Systems, Inc.; Wiremold Company (The).
 - c. Wiremold Company (The); Electrical Sales Division.
 2. Provide types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceway.

2.05 LOW VOLTAGE CABLING SUPPORT

- A. General: The following supporting products are for use in systems below 50V.
- B. Open top cable supports (J-Hooks):
 1. Galvanized steel construction with smooth rounded edges.
 2. Complies with UL, cUL, NEC, and ANSI/TIA/EIA requirements for structured cabling systems.

3. Manufacturers:
 - a. Erico.
 - b. B-Line.
 - c. Panduit.

2.06 COMMUNICATIONS RACEWAY ACCESSORIES

- A. Pull cords:
 1. Pull wires shall be nylon type.
 2. Provide in all empty conduits, sleeves, raceways, and all cabling pathways for future use.
 3. Pull cords shall have a tensile rating of 200 pounds minimum.
- B. Fiber Optic Innerduct:
 1. NEMA TC 5, UL listed, corrugated, specifically designed for optical fiber cable pathways.
 2. Fiber optic innerduct shall be orange in color.
 3. Innerduct shall be 1-inch minimum inside diameter, and a minimum pulling strength of 600 pounds.
 4. Each innerduct shall include a factory installed pull rope.
 5. Each duct shall be suited for the environment in which it is installed.
 6. Manufacturers:
 - a. Carlon.
 - b. Arnco.
 - c. Opti-Com.
 - d. Maxcell.
- C. Cable Spillways:
 1. Provide Spillway on sleeves 2 inches and greater.
 2. Manufacturers:
 - a. Bejed.
 - b. BLine.
 - c. Panduit.

PART 3 - EXECUTION

3.01 METALLIC AND NON-METALLIC CONDUIT APPLICATION

- A. The following schedule shall be followed for all installations unless it creates a violation of applicable codes or is otherwise specifically dictated otherwise within the drawings.
 1. Outdoor Locations Above Grade (Including Roofs): RMC
 2. Indoor Locations:
 - a. Exposed, not subject to physical damage, or above 7 feet-0 inches of finished floor: RMC, IMC or EMT.
 - b. Exposed, subject to physical damage, or within 7 feet-0 inches of finished floor: RMC, IMC.
 - c. Finished spaces, concealed above suspended ceilings and interior walls and partitions: EMT.
 - d. Wet or Damp Locations: RMC or IMC.
 3. Connections to vibrating equipment: FMC, except use LFMC in wet or damp locations.
 4. Optical Fiber or Communications Cable: EMT or Flexible type, listed for purpose.
- B. Conduit Size:
 1. Conduits shall be sized as shown on drawings. Where conduit sizes are not indicated, conduits shall be sized in accordance with the latest version of the National Electrical Code (NFPA 70) and shall be limited to a 40 percent conductor fill percentage. Conductor ampacities must be maintained; therefore, adjustment factors for temperature and quantity derating values must be observed.
 - a. Minimum Conduit Size: Unless otherwise noted, 3/4-inch (21-mm) trade size with the following exceptions:

- 1) Switchlegs, Luminaire Whips and Control Wiring: 1/2-inch.
 - 2) Below Grade: 1-inch.
- b. Conduit sizes may change only at the entrance or exit of a junction box.

3.02 METALLIC AND NON-METALLIC CONDUIT INSTALLATION

A. General Installation Requirements

1. Conduits shall be mechanically and electrically continuous from source of current to all outlets unless a properly sized grounding conductor is routed within the conduit. All metallic conduits shall be bonded per NFPA 70.
2. Do not reduce the indicated sizes of raceways. Conduit sizes may only change junction and pull boxes.
3. Complete raceway installation before starting conductor installation.
4. Use temporary closures to prevent foreign matter from entering raceway.
5. Avoid moisture traps; provide junction box with drain fitting at low points in raceway system.
6. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Empty raceways shall be labeled at each end indicating origin of the raceway. Labels shall be self-adhesive vinyl labels.
7. Raceways containing feeders and circuits associated with branches of the essential power system, the emergency power system, the legally required power system, the optional standby system must be kept entirely independent from each other and other sources of power.

B. Conduit Routing:

1. Conduit shall be concealed in walls and above ceilings within finished spaces and may be exposed within unfinished spaces (such as mechanical and utility areas) where conditions dictate and as practical. Where routed exposed, headroom shall be maintained for pedestrian and vehicular traffic.
2. Raceway routing proposed on Drawings is diagrammatic in nature and shown in approximate locations unless dimensioned. Coordinate conduit routing with beams, joists, columns, windows, etc., as required to complete wiring system. Verify field measurements, routing and termination locations of raceway with obstructions and other trades prior to rough-in.
3. Conduit installation shall be coordinated with all other systems on the project. The Construction Team shall exchange details of their work in order to ensure adequate and coordinated fit of all systems within ceiling spaces and exposed unfinished areas.
4. Run concealed raceways with a minimum of bends in the shortest practical distance considering the type of building construction and obstructions, except as otherwise indicated.
5. Route exposed conduit and conduits above ceilings parallel and perpendicular to building structural lines, and as close to building structure as possible.
6. Raceways are not to cross pipe shafts or ventilating duct openings, nor are they to pass through HVAC ducts. Support riser raceway at each floor level with clamp hangers. Maintain adequate clearance between raceway and piping.
7. Coordinate layout and installation of conduit with other construction elements to ensure adequate headroom, working clearance and access.
8. Route conduit through roof openings provided for piping and ductwork or rooftop unit curbs where possible. Where unavoidable, route conduit through suitable roof jack with pitch pocket. Coordinate roof penetrations with other trades.
9. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
10. Do not install aluminum conduits in contact with concrete.

11. Raceways routed under-slab on grade must be a minimum of 12 inches below the concrete slab.
- C. Conduit Supports:
1. Install raceways level and square and at proper elevations. Provide adequate headroom. Group related conduits; support using conduit rack. Construct rack using steel channel. All conduit supports shall be secured to walls, structural members, slabs, and bar joists. Do not support conduits from non-structural members, such as ductwork, water or fire suppression piping, or ceiling grid support system.
 1. Run parallel or banked raceways together, on common support racks where practical and make bends from same center line to make bends parallel. Use factory elbows only where they can be installed parallel; otherwise, provide field bends for parallel raceways. Provide space within each rack for 20 percent additional conduits.
 2. Support raceways as specified in Division 26 Section "Hangers and Supports."
- D. Conduit Fittings and Terminations:
1. 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.
 2. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
 3. Install raceway sealing fittings according to the manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL-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 where conduits enter or leave hazardous locations, where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces, such as kitchen cold boxes, air-conditioned spaces and other places indicated on the drawings or required by NFPA 70.
 4. Expansion/Deflection Joints: Provide suitable fittings to accommodate expansion and contraction where raceway crosses seismic and expansion joints. Install expansion fittings in the full open position if installed during a period of lowest expected temperature, and in the fully closed position if installed during a period of highest expected temperature. Install at proportionate intermediate position for intermediate temperatures.
 - a. In addition to the foregoing, provide expansion fittings according to the following table, for exposed linear runs or runs in hung ceilings where such runs do not contain junction boxes, pull boxes, nor bends totaling more than 30 degrees.
 - b. EMT and RMC expansion couplers shall be UL listed with an internal copper braided bonding jumper that meets the requirements of NEC 250.98. Fitting shall be listed as suitable for wet locations and rainwater tight when installed in wet or outdoor locations.

Raceway Material	Indoor, conditioned areas	Outdoors and non-conditioned areas
Steel	ONE EXPANSION FITTING IN RUNS LONGER THAN 80 FEET, ADDITIONAL EXPANSION FITTINGS EVERY 400 FEET	One expansion fitting in runs longer than 40 feet, additional expansion fittings every 200 feet
PVC	One expansion fitting in runs longer than 20 feet, additional expansion fittings every 100 feet	One expansion fitting in runs longer than 10 feet, additional expansion fittings every 50 feet

5. Flexible Connections: Use maximum of 6 feet of flexible metal conduit for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement and for all motors. Use Liquidtight flexible metal conduit in wet or damp locations. Install ground conductor across flexible connections.
6. PVC Externally Coated Rigid Steel Conduit: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduit. All installations shall be completed by a factory certified installer.
7. Avoid use of dissimilar metals throughout system to eliminate possibility of electrolysis. Where dissimilar metals are in contact, coat surfaces with corrosion inhibiting compound before assembling.

E. Conduit Bends:

1. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.
2. Make bends and offsets so the inside diameter is not reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel.
3. Use conduit benders to make sharp changes in direction, as around beams. Use hydraulic one-shot bender when field-fabricated elbows are required for bends in metal conduit larger than 2 inch size.
4. Stub-Up Connections: Use type of conduit described for stub-ups from slab. Extend conduit through concrete floor for connection to freestanding equipment to a distance 6-inches above the floor. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

3.03 WIREWAY INSTALLATION

- A. Wireway shall be securely fastened to walls using steel channels. Mount plumb and level.
- B. Raintight wireways may only be installed in horizontal orientations.

3.04 SURFACE RACEWAY INSTALLATION

A. Surface Metal Raceways:

1. Install surface metal raceway with all necessary offsets, fittings, bends and boxes to comprise a complete system. Provide manufacturer raceway accessories as needed. Mount plumb and level.
2. Install a separate green ground conductor in raceway from the junction box supplying the raceway to receptacle or fixture ground terminals. Maintain grounding continuity throughout surface metal raceway components.

3.05 COMMUNICATIONS RACEWAY INSTALLATION REQUIREMENTS

- A. General:

1. These guidelines are intended to supplement the requirements listed in other portions of this specifications section.
 2. Minimum raceway size shall be as necessary to comply with fill ratio of referenced standards, but in no case less than 1 inch.
 3. Provide specified pull wires in all cabling pathways.
 4. Ground and bond all systems in accordance with the NEC and ANSI/TIA/EIA 607.
 5. All installation material and practices shall fully comply with NFPA 70 "National Electrical Code" and ANSI/TIA/EIA 569A Commercial Building Standard for Telecommunications Pathways and Spaces (BICSI).
 6. Coordinate work with the building structural systems and electrical installation.
 7. All work shall fully comply with these Specifications and related Drawings and all manufacturers' recommended installation practices.
 8. Do not install conduit in concrete slab.
 9. There shall not be more than the equivalent of 180 degrees of bends in any single run of conduit between adequately sized pull.
 10. Conduits entering a Telecommunications room below the finished ceiling shall be extended a minimum of 4-inches below the ceiling and shall be routed as tight to the adjacent wall as possible.
 11. Conduits entering a Telecommunications room through a wall shall extend 15 inches into the room and kept a minimum of 8 feet above finished floor.
 12. Conduit bends:
 - a. Bends shall be made so that the conduit will not be flattened or kinked and the internal diameter of the conduit will not be reduced.
 - b. The radius of the curve of the inner edge of any bend shall not be less than as indicated by the National Electrical Code and ANSI/TIA/EIA 569A Commercial Building Standard for Telecommunications Pathways and Spaces.
 - c. In no case shall any conduit be bent, or any fabricated elbow be applied to less than the allowable bending radius as specified by the cable manufacturer of the installed conductor.
 - d. When necessary to make field bends, use tools designed for conduit bending. Heating of metallic conduit to facilitate bending is not permitted.
 13. A conduit run shall not be longer than 100 feet between pull boxes for conduit runs inside a building.
 14. Do not cut, burn or drill any structural member to mount electrical equipment or to facilitate tray or conduit installations without having previously received approval, in writing, from the Architect/Engineer/Consultant.
 15. Mount all conduit a minimum of 3 inches above any accessible type ceiling.
 16. Maintain conduit runs at least 6 inches from insulate pipes, steam lines or any other hot pipes they pass. Where the lines are not insulated, the clearances shall be increased until the temperature of the conduit, with no live conductors enclosed, does not rise above the ambient temperature of the installation area.
- B. Communications Pathway Separation Requirements:
1. Provide separation of communications pathways to minimize the effects of electromagnetic interference (EMI) by installing pathways in the following manner:
 - a. Provide a minimum of 12 inches separation from power lines exceeding 5kV and communications pathways not concealed in metallic conduit.
 - b. Provide a minimum of 6 inches separation from power lines exceeding 5kV and communications pathways concealed properly bonded in metallic conduit.
 - c. Provide a minimum of 37 inches separation from electrical motors and transformers and communications pathways.
 - d. When power lines or cables of different signal conditions must intersect, crossing shall be made at 90-degree angle, with proper separation as outlined above.

3.06 SEISMIC REQUIREMENTS

- A. Whenever Specification Section 20 0800 "Seismic Protection" is included in these specifications, the following is also required for those life safety, emergency, fire alarms, etc., conduits that are defined therein. Details on the drawings, when shown, are intended to clarify or supplement these requirements:
 - 1. All expansion joints shall be considered seismic joints that can cause movement in any direction during a seismic event. Conventional expansion fittings are not adequate for this condition.
 - 2. For exposed conduit runs or runs in hung ceilings, provide a length of flexible metal conduit across the joint that will allow 2 inches of conduit movement in any direction. Length of the flexible section shall not exceed 6 feet.

3.07 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.08 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.09 CLEANING

- A. Upon completion of installation of system, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

3.10 MARKING AND IDENTIFICATION

- A. Mark and identify conduits in accordance with Section 26 0553 "Identification for Electrical Systems."
- B. Mark and identify communications conduits in accordance with Section 27 0553 "Identification for Communications Systems."

3.11 RECORD DOCUMENTS

- A. Accurately record actual routing of all feeder and sub-feeder conduits regardless of size and branch circuits conduits larger than 2-inches.

END OF SECTION

THISPAGELEFT INTENTIONALLY BLANK

SECTION 26 0534
BOXES, CABINETS, AND ENCLOSURES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes boxes, cabinets, and enclosures for electrical wiring.

1.03 SUBMITTALS

- A. Submittals for approval by the Engineer are not required for this section. Unrequested submittals will not be processed or reviewed. Non-requirement of submittals is not to be construed as an allowance for substitutions and does not allow relief from full compliance with the contract documents.

1.04 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. Comply with the following standards:
 - 1. NECA "Standard of Installation."
 - 2. NEMA OS 1: Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports.
 - 3. NEMA OS 2: Non-Metallic Outlet Boxes, Device Boxes, Covers and Box Supports.
 - 4. NEMA FB 1: Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable.
 - 5. NEMA 250: Enclosures for Electrical Equipment (1000 Volts Maximum)

PART 2 - PRODUCTS

2.01 OUTLET BOXES

- A. General: Outlet boxes shall be constructed in accordance with National Electrical Code Article 314. Outlet boxes shall be sized for the volume required by the National Electrical Code, but in no case shall they be less than 1-1/2 inches deep.
- B. Sheet Metal Boxes: Comply with NEMA OS 1, galvanized steel.
- C. Nonmetallic Outlet Boxes: Comply with NEMA OS 2.
- D. Cast Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy or aluminum, type FD with gasketed cover and threaded hubs.
- E. Boxes for receptacle, telephone and data outlets shall be 4-11/16 inches square by 2-1/8 inches deep and shall be provided with extension rings. Furnish outlet boxes with fixture studs where required.
- F. Boxes for voice and/or data outlets shall be minimum 5 inches square by 2-1/8 inches deep and shall be provided with extension rings. Furnish outlet boxes with fixture studs where required.
- G. Boxes for switches or local light control shall be 4 inches square by 1-1/2 inches deep and shall be provided with raised cover to fit flush with finished wall line. Provide single box for multiple-ganged devices with single cover plate, sized for the quantity of devices to be installed.
- H. Provide 4-inch octagonal and square outlet boxes for all exposed conduit work with fixture extension pan or deep fixture canopy to enclose the outlet box.
- I. Boxes for recessed light fixtures shall be 4-inch octagonal or square according to fixture hardware requirements, minimum 1-1/2 inches deep complete with blank cover.

- J. Provide corrosion-resistant steel knockout closures for unused openings.

2.02 FLOOR BOXES

- A. Metal Floor Boxes: Cast metal, fully adjustable, rectangular.

2.03 JUNCTION AND PULL BOXES

- A. Small Sheet Metal Pull and Junction Boxes: Comply with NEMA OS 1, galvanized steel. Flush-mounted boxes shall have an overlapping cover.
- B. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1, galvanized or aluminum with gasketed cover.
- C. Covers: Covers shall be the same material as the box. Covers shall be on the largest access side of the box, unless otherwise indicated.
 - 1. Less than 12 inches in any dimension: Screw-on cover.
 - 2. Greater than 12 inches in any dimension: Hinged cover.
- D. Hinged-Cover Enclosures: Comply with 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.

2.04 CABINETS AND ENCLOSURES

- A. Comply with NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
- B. Provide metal barriers to separate wiring of different systems and voltage.
- C. Hinged Cover: Hinged door in front cover with flush latch and concealed hinge.
- D. Where lockable cabinets are provided, key latch to match panelboards.
- E. Provide accessory feet where required for freestanding equipment.

PART 3 - EXECUTION

3.01 BOX AND CABINET INSTALLATION

- A. General Installation Requirements:
 - 1. Electrical boxes are shown on drawings in approximate locations unless dimensioned. The Engineer or Architect shall be allowed to adjust the location of boxes up to 10 feet in any direction without additional cost to the project. This is intended for boxes for receptacles and switches and other wiring devices.
 - 2. Provide boxes as shown and for splices, taps, wire pulling, equipment and fixture connections and where required by applicable codes and installation practices.
 - 3. Locate boxes to maintain headroom and present a neat appearance. Locate to allow proper access. Provide access doors for boxes located above inaccessible ceilings.
 - 4. Provide knockout closures to cap unused knockout holes where blanks have been removed.
 - 5. Support all boxes, cabinets, and enclosures rigidly and independently of conduit except where specifically allowed by the National Electrical Code. Use supports suitable for the purpose.
 - 6. Boxes located outdoors above ground shall be raintight and gasketed cast aluminum.
 - 7. Provide covers for all boxes.
 - 8. Do not install boxes back-to-back in same wall. Provide at least 6-inch separation or greater where required by the building code. In hollow fire walls, maintain minimum 24-inch horizontal separation between outlets on opposite sides. As an alternate to the 24-inch separation, the use of listed putty pads or other listed materials and methods approved by the Authority Having Jurisdiction are acceptable.
- B. Outlet Box Installation:

1. All devices (receptacles, switches, occupancy sensors, fire alarm devices, low voltage devices, telephone jacks, TV jacks, data jacks, microphones jacks, etc., and any other device) furnished under this project shall be mounted on or in an outlet box regardless of whether or not the associated system wiring is in conduit, unless otherwise noted.
 2. Flush-mount outlet boxes in finished areas. Outlets in mechanical rooms, electrical rooms, and the above removable ceilings may be surface-mounted.
 3. Use multiple gang boxes where more than one device is mounted together. Provide barriers to separate different voltage systems.
 4. For outlets mounted above counters, benches, or backsplashes, coordinate location and mounting heights with architectural details. Install with bottom of box minimum 6 inch above backsplash.
 5. Align wall-mounted outlet boxes for switches, thermostats, and similar devices.
 6. Adjust outlet mounting height and horizontal location to agree with required location for equipment served as may be shown on installation instructions or shop drawing for the equipment.
 7. Position outlets to locate luminaires as shown on reflected ceiling drawings. For recessed boxes in finished areas, secure to interior wall and partition studs; allow for surface finish thickness.
 8. Ensure that thermal insulation will be in place behind outlet boxes before installing them in insulated walls. Do not damage insulation.
 9. Special care shall be taken to set all flush boxes square and true with the building finish. The edge of the cover shall meet the building finish or be no greater than 1/8 inch back from the finish surface. All wall outlets shall be rigidly secured to the stud system, using adjustable supports where necessary, to prevent all box movement.
 10. Do not set boxes back further than required by Code. Coordinate with building finishes. Do not install any box so that the device pushes back into the wall when pushed. All boxes are to be set so that the device yoke will securely bear upon the box or wall finish. Where the sheetrock contractor cuts an opening too big for this to be achieved, install a fitting such as Caddy # RLC.
 11. Installation within Masonry walls:
 - a. Adjust position of outlets in finished masonry walls to suit masonry course lines where possible. Do not, however, violate maximum heights defined by accessibility codes such as ADA.
 - 1) Coordinate cutting in of walls to achieve neat openings for boxes. Locate boxes in walls so that only the corner need be cut from masonry units where possible.
 - 2) 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.
 12. Outlet Box Application: Unless otherwise noted, outlet boxes shall be installed as follows:
 - a. Galvanized Steel Box Installation Locations:
 - 1) Concealed interior locations.
 - 2) Exposed interior locations above 7 feet-0 inches of finished floor.
 - b. Cast Box Installation Locations:
 - 1) Exterior locations.
 - 2) Hazardous locations.
 - 3) Exposed interior locations within 7 feet-0 inches of finished floor.
 - 4) Wet or damp locations.
- C. Pull and Junction Boxes:
1. Locate above accessible ceilings or in unfinished areas.
 2. Locate pull or junction boxes to limit conduit runs to no more than 150 linear feet of four (4) 90-degree bends between pulling points. For telephone/ data limit bends to no more than three (3) 90-degree bends to pulling points.
- D. Cabinets and Enclosures:

1. Install hinged cover enclosures and cabinets plumb. At a minimum, support at each corner.
2. Provide knockout closures to cap unused knockout holes where blanks have been removed.

3.02 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.03 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

3.04 CLEANING

- A. Upon completion of installation of system, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

3.05 MARKING AND IDENTIFICATION

- A. Mark and identify boxes, cabinets, and enclosures in accordance with Section 26 0553 "Identification for Electrical Systems."

END OF SECTION

SECTION 26 0536

CABLE TRAYS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Cable trays.
 - 2. Cable tray accessories.

1.03 SUBMITTALS

- A. Product Data: Include for each tray type, dimensions, support points, clamps, hangers, connectors, fittings, expansion joint assemblies, accessories, and finishes.
- B. Shop Drawings: For each type of cable tray.
 - 1. Show fabrication and installation details of cable tray, 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. 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.
 - a. Design Calculations: Calculate requirements for selecting seismic restraints.
 - b. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.
- C. Coordination Drawings: The contractor shall be responsible for coordinating the cable tray layout with all building components (ducts, pipes, fire protection, columns, beams, walls, etc.). Make changes in cable tray direction and elevation as required. Provide floor plans and sections, drawn to scale. Include scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements. Show the following:
 - 1. Vertical and horizontal offsets and transitions.
 - 2. Clearances for access above and to side of cable trays.
 - 3. Vertical elevation of cable trays above the floor or bottom of ceiling structure.

1.04 QUALITY ASSURANCE

- A. Source Limitations: Obtain cable tray components through one source from a single manufacturer.
- B. 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.
- C. Comply with the following codes and standards:
 - 1. NFPA 70.
 - 2. ASTM B 633.
 - 3. ASTM F 593.
 - 4. ASTM F 594.
 - 5. ASTM F 1136.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Store indoors to prevent water or other foreign materials from staining or adhering to cable tray. Unpack and dry wet materials before storage.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.
 - 1. Temperature Change: 120 degrees F, ambient; 180 degrees F, material surfaces.

2.02 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 drawings for specific requirements for types, materials, sizes, and configurations in specific locations.
- C. Structural Performance: See articles on 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 2.
 - 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.

2.03 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Legrand Cablofil.
 - 2. PW Industries.
 - 3. Cooper B-Line, Inc.
 - 4. Cope, T. J., Inc.; a subsidiary of Allied Tube & Conduit.
 - 5. MONO-SYSTEMS, Inc.
 - 6. MPHusky.
 - 7. Chalfont Manufacturing Company.
 - 8. Thomas & Betts.

2.04 LADDER-TYPE CABLE TRAYS

- A. Description:
 - 1. Configuration: Two I-beam side rails with transverse rungs welded to side rails.
 - 2. Rung Spacing: 9 inches on center.
 - 3. Radius-Fitting Rung Spacing: 9 inches at center of tray's width.
 - 4. Minimum Cable-Bearing Surface for Rungs: 7/8-inch width with radius edges.
 - 5. No portion of the rungs shall protrude below the bottom plane of side rails.
 - 6. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb (90-kg) concentrated load, when tested according to NEMA VE 1.
 - 7. Minimum Usable Load Depth: 4 inches.
 - 8. Straight Section Lengths: 12 feet except where shorter lengths are required to facilitate tray assembly.
 - 9. Width: 12 inches and 24 inches unless otherwise indicated on Drawings.
 - 10. Fitting Minimum Radius: 12 inches.
 - 11. Class Designation: Comply with NEMA VE 1, Class 12C.
 - 12. Splicing Assemblies: Bolted type using serrated flange locknuts.
 - 13. Hardware and Fasteners: stainless-steel, Type 316.
 - 14. Splice Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

- B. Materials and Finishes:
 - 1. Aluminum:
 - a. Materials: Alloy 6063-T6 according to ANSI H35.1/H 35.1M for extruded components, and **Alloy 5052-H32** according to ANSI H35.1/H 35.1M for fabricated parts.
 - b. Hardware: **Stainless-steel, Type 316.**
 - c. Hardware for Aluminum Cable Tray Used Outdoors: Stainless-steel, Type 316, ASTM F 593 and ASTM F 594.
- C. Cable Tray Accessories:
 - 1. Accessories: Provide all supporting, hanging, tee, cross, level change, reducing, drop outs, and miscellaneous hardware as required for a complete and functioning installation to manufacturer's recommendations.
 - 2. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
 - 3. Barrier Strips: Same materials and finishes as for cable tray.
 - 4. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.
- D. Cable Dropouts ("Waterfalls"):
 - 1. Shall mount securely to ladder rack rails and shall maintain minimum bend radius on all cables entering or exiting the Ladder Rack.
- E. Cable Fencing:
 - 1. Minimum 7 inches high, at 3 feet-0 inches on center for entire route of cable tray.

2.05 WARNING SIGNS

- A. Provide manufacturer's standard, permanent, legible warning label indicating the following:

WARNING! DO NOT USE AS A WALKWAY, LADDER, OR SUPPORT FOR PERSONNEL. TO BE USED ONLY AS MECHANICAL SUPPORT FOR CABLES AND TUBING!

- B. Label shall also indicate cable tray NEMA load class. Label shall be a maximum of 10' on center.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. General Installation Requirements
 - 1. Refer to the drawings for specific cable tray routings, sizes, types, and accessories to be installed in specified locations.
 - 2. Cable tray shall be installed parallel and perpendicular to building structural and wall lines.
 - 3. Install cable tray in accessible locations only. Where portions of a cable tray route will be inaccessible, provide conduit sleeves for the duration of the inaccessible route. Conduit sleeves shall have cable capacity equal to or greater than the capacity of the cable tray being supplemented.
 - 4. Install in conformance with NEMA VE 2 requirements and in accordance with manufacturer's instructions.
 - 5. Support cable tray at each connection point, at the end of each run, and at other points to maintain spacing between supports of 12 feet maximum.
 - 6. Tray shall be electrically continuous from source to termination and shall not change elevation, direction or otherwise expose cables to travel without support.
 - 7. All splices of tray shall be provided with splice washers, bars or springs as recommended by the manufacturer.

8. Provide bonding continuity between cable tray sections, fittings and conduit terminations in accordance with manufacturer's instructions. Make connections to aluminum tray and fittings using an antioxidant compound.
9. 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.
10. Remove burrs and sharp edges from cable trays.
11. Seal penetrations through fire and smoke barriers.
12. Install capped sleeves for future cables through firestop sealed cable tray penetrations of fire and smoke barriers as shown on drawings.
13. Install cable trays with sufficient space to permit access for installing cables. Install tray bottom within 18 inches U.N.O., of access ceiling paneling for ease of access. Adjust mounting height only momentarily for field coordination with other trades and systems as required.
14. Provide separation of cables of different systems, such as power, telecommunications, fire alarm system, security systems and audio or visual systems. Install barriers between power and low voltage cables.
15. Provide seismic bracing of cable tray in accordance with Division 20 Section "Seismic Protection."
16. Install cable trays according to NEMA VE 2.
17. 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.
18. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.
19. Join aluminum cable tray with splice plates; use four square-neck carriage bolts and locknuts.
20. Fasten cable tray supports to building structure and install seismic restraints.
21. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb. Comply with requirements in Section 26 0529 "Hangers and Supports for Electrical Systems." Comply with seismic-restraint details according to Section 26 0548.16 "Seismic Controls for Electrical Systems."
22. Place supports so that spans do not exceed maximum spans and provide clearances as required. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.
23. 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.
24. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.
25. Locate and install supports according to NEMA VE 2. Do not install more than one cable tray splice between supports.
26. 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.
27. The contractor shall be required to make changes in direction and elevation in order to provide a continuous cable tray routing as indicated on the construction documents and engineer approved coordination drawings. Changes in direction and elevation shall be made using manufacturer's recommended fittings.
28. Make cable tray connections using manufacturer's recommended fittings.
29. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 07 8413 "Penetration Firestopping."

30. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.
31. Install cable trays with enough workspace to permit access for installing cables.
32. 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.
33. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.
34. Clamp covers on cable trays installed outdoors with heavy-duty clamps.
35. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.02 CABLE TRAY GROUNDING

- A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 26 0526 "Grounding and Bonding for Electrical Systems."
- B. Cable trays with electrical power conductors 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 (1800-mm) 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."

3.03 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 (450 mm).
- 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 (1800 mm).
- E. Tie MI cables down every 36 inches (900 mm) where required to provide a 2-hour fire rating and every 72 inches (1800 mm) elsewhere.
- F. In existing construction, remove inactive or dead cables from cable trays.

3.04 CONNECTIONS

- A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.
- B. Connect raceways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.
- C. Install cables only when cable tray installation has been completed and inspected.
- D. In existing construction, remove inactive or dead cables from cable tray.
- E. Ground cable trays according to manufacturer's written instructions.

- F. Install an insulated equipment grounding conductor with cable tray, in addition to those required by NFPA 70.
- G. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA FG 1.

3.05 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 retorqued 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.

3.06 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

SECTION 26 0553
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Identification for medium voltage systems.
 - 2. Identification for underground systems.
 - 3. Identification for raceways.
 - 4. Identification for wires, cables, and conductors.
 - 5. Floor marking tape.
 - 6. Warning labels and signs.
 - 7. Instruction signs.
 - 8. Equipment identification labels.
 - 9. Miscellaneous identification products.

1.03 SUBMITTALS

- A. Submittals for approval by the Engineer are not required for this section. Unrequested submittals will not be processed or reviewed. Non-requirement of submittals is not to be construed as an allowance for substitutions and does not allow relief from full compliance with the contract documents.

1.04 QUALITY ASSURANCE

- A. Comply with the following standards:
 - 1. ANSI A13.1 and IEEE C2.
 - 2. NFPA 70.
 - 3. 29 CFR 1910.144 and 29 CFR 1910.145.
 - 4. ANSI Z535.4 for safety signs and labels.
- B. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.05 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Electromark - Wolcott, New York.
 - 2. Ideal Industries, Inc.
 - 3. 3M.

4. Panduit Corp.
5. Seton Name Plate Co.
6. Thomas & Betts.
7. W. H. Brady, Co. - Signmark Division - Milwaukee, Wisconsin.

2.02 ELECTRICAL IDENTIFICATION PRODUCTS

- A. Self-Adhesive Vinyl Labels (Raceways and Boxes): Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- B. Self-Adhesive Vinyl Tape for Banding (Raceway, Wire and Cable): Colored, heavy duty, waterproof, fade resistant; 2 inches wide.
- C. Self-Adhesive Tape Markers (Wire and Cable): Vinyl or vinyl-cloth, self-adhesive, wraparound, cable and conductor markers with preprinted numbers and letters.
- D. Snap-Around, Color-Coding Bands (Raceways and Cables): Slit, pre-tensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- E. Colored Adhesive Marking Tape (Raceways, Wires, and Cables): Self-adhesive latic-coated cloth tape similar to Brady 441XX or 442XX series.
- F. Conductor Identification Products:
 1. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.
 2. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- G. Floor Marking Tape:
 1. 2-inch- (50-mm-) wide, 5-mil (0.125-mm) pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.
- H. Underground Line Warning Tape:

2.03 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door or other access to equipment unless otherwise indicated.
- C. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application with 1/4-inch (6.4-mm) grommets in corners for mounting, nominal 7 by 10 inches in size unless noted otherwise.
- D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, non-fading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application. Provide 1/4-inch (6.4-mm) grommets in corners for mounting, nominal 10 by 14 inches in size unless noted otherwise.
- E. Plasticized Card Stock Tags: Vinyl cloth with preprinted and field-printed legends to suit the application. Orange background, except as otherwise indicated, with eyelet for fastener.
- F. Engraved, Plastic-Laminated Labels, Signs, and Instruction Plates: Engraving stock melamine plastic laminate, 1/16-inch minimum thick for signs up to 20 square inches, or 8 inches in length; 1/8-inch thick for larger sizes. Engraved legend in black letters on white face and punched for mechanical fasteners.

2.04 EQUIPMENT IDENTIFICATION LABELS

- A. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Overlay shall provide a weatherproof and UV-resistant seal for label. Labels shall be at least 2-1/4 inches high. Where space does not permit this label size, smaller stock and lettering is permitted.
- B. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with lettering and background colors as indicated. Labels shall be at least 2-1/4 inches high. Where space does not permit this label size, smaller stock and lettering is permitted.
- C. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Labels shall be at least 2-1/4 inches high. Where space does not permit this label size, smaller stock and lettering is permitted.

2.05 CABLE TIES

- A. Cable Ties: Fungus-inert, self-extinguishing, nylon one-piece, self-locking cable ties, 0.18-inch minimum width, 50-lb minimum tensile strength, and suitable for a minimum temperature range from minus 50 degrees F to 350 degrees F. Provide ties in specified colors when used for color-coding.
- B. Identification Cable Ties: Same as "Cable Ties" above, except with integral tab of suitable size for marking requirements.

2.06 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Increase size of labels and letters to those appropriate for viewing from the floor for elevated components.
- C. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by code.
- D. Install identification devices in accordance with manufacturer's written instructions and requirements of NEC.
- E. Clean and degrease surfaces prior to applying identification products. Apply identification to surfaces that require finish after finish work is completed. Utilize primer for metal surfaces, heavy-duty acrylic resin block filler for concrete masonry, and clear alkali-resistant alkyd binder-type sealer for concrete surfaces.
- F. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- G. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
- H. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
- I. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.02 LABEL COLOR CODE LEGEND

- A. Provide the following color-coding scheme for each label based on the power system it is identifying:
1. Normal Power: Black letters on white background.
 2. Critical Power: White letters on red background.
 3. Life Safety Power: White letters on green background.
 4. Equipment Power: White letters on blue background.

3.03 RACEWAY IDENTIFICATION

- A. Identify Raceways of Certain Systems with Color Banding: Band exposed and accessible raceways of the following systems for identification. Bands shall be pre-tensioned, snap-around colored plastic sleeves, colored adhesive marking tape, or a combination of the two. Make each color band 2 inches wide, completely encircling conduit and place adjacent bands of two-color markings in contact, side by side. Install bands at changes in direction, at penetrations of walls and floors and at 20-foot maximum intervals in straight runs. Apply the following colors:
1. Primary Distribution System: Grey.
 2. Normal Distribution System (480/277V): Orange.
 3. Normal Distribution System (208/120V): White.
 4. Emergency Distribution System (480/277V): Orange/Yellow Bands.
 5. Emergency Distribution System (208/120V): White/Yellow Bands.
 6. Ground: Green.
 7. Fire Alarm System: Red.
 8. Motor and Control Systems: Black.
 9. Temperature Controls/Building Automation: Blue.
 10. Telecommunications: Blue/White Bands.
 11. Clock, Sound, Intercom: Blue/Black Bands.
 12. Nurse Call System: Purple.
 13. Security System: Black/White Band.
 14. At contractor option, manufacturer painted EMT conduit (when EMT conduit is allowed or required to be used for the above systems), may be utilized in lieu of the banding noted above. Fittings would not have to be painted.
- B. Where conduits leave a switchboard, panelboard, motor control center, etc., identification shall be provided on each conduit indicating the load being served.
- C. Contractor shall be responsible for providing the Owner with laminated, colored, typewritten legends indicating the identification color scheme. At a minimum, these legends should be installed in the main electrical room and branch electrical closets. Provide two additional legends to the Owner to use at their discretion.
- D. Identification of Raceways with Labeling:
1. Raceway Labeling: Provide labeling on conduits indicating electrical distribution system contained within (e.g. Normal, Life Safety, etc.) and operating voltage level. Label size shall be as follows:

Nominal EMT conduit size	Nominal RGS conduit size	Length of color background on label	Height of letters
up to 1 inch	up to 3/4 inch	8 inches	1/2 inch
1.25 to 1.5 inches	1 to 1.5 inches	8 inches	3/4 inch
2 to 5 inches	2 to 5 inches	12 inches	1.25 inches
6 inches	6 inches	24 inches	2.5 inches

2. 20-inch (500mm) centers to read as follows: "DANGER CONCEALED HIGH VOLTAGE WIRING."

3.04 BOX IDENTIFICATION

- A. Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage:
 1. Normal Power.
 2. Critical, Life Safety and Equipment Power.
- B. At each junction, pull and connection box, identify the following: with self-adhesive vinyl labels or permanent marker (color coded) neatly hand printed. Identification of these boxes shall be located on the inside of cover if located in finished spaces:
 1. Power and lighting circuits: Indicate system voltage and identify contained circuits and panelboard serving load (e.g., "120V, PP1-1, 3, 5").
 2. Other wiring: Indicate system type and wiring description (e.g., "FIRE ALARM NAC #2").
- C. Paint box covers to correspond with system types as follows:
 1. Fire Alarm: Red.
 2. Temperature Control/Building Automation System: Blue.

3.05 CIRCUIT IDENTIFICATION

- A. Label conductors as follows:
 1. Multiple Power or Lighting Circuits in the Same Enclosure: Where multiple branch circuits are terminated or spliced in a box or enclosure, label each conductor with source and circuit number.
 2. Multiple Control Wiring and Communication/Signal Circuits in Same Enclosure: For control and communications signal/wiring, use wire/cable marking tape at terminations in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tape.

3.06 CONDUCTOR COLOR CODING

- A. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, panelboards, manholes, handholes, switches, etc., use color-coding conductor tape to identify the phase.
 1. Color-Coding for Conductors rated 600 V or Less: Use colors listed below for all conductors.
 - a. Color shall be factory-applied, or field-applied for sizes larger than No. 6 AWG, if Authorities Having Jurisdiction permit
 - 1) Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
 - b. Colors for 208/120V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.

- 3) Phase C: Blue.
 - 4) Neutral: White.
 - 5) Ground Bond: Green.
 - c. Colors for 480/277V Circuits:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - 4) Neutral: Gray.
 - 5) Ground Bond: Green.
- B. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control and signal connections.
 1. Identify conductors, cables and terminals in enclosures and at junctions, terminals and pull points. Identify by system and circuit designation.
 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- C. Open Cable Identification
 1. Low Voltage Cable (Less than 120V): Provide self-adhesive pre-printed vinyl tape markers at 20-foot intervals to identify all cables run exposed or located above the accessible ceilings. Indicate the associated system by using the following color-coding schemes:
 - a. Fire Alarm: Red lettering on white background.
 - b. Temperature Controls: Blue lettering on white background.
 - c. Security System: Black lettering on white background.
 - d. Telephone System: White lettering on blue background.

3.07 RECEPTACLE IDENTIFICATION

- A. Identification Material: Pre-printed, self-laminating vinyl labels, 3/16-inch font height. Utilize black lettering on clear background for normal power circuits and red lettering on a clear background for emergency power circuits.
- B. Cover plates: Provide identification on all receptacle cover plates indicating the source panelboard and circuit number serving the device (e.g., PP1#1).

3.08 SIGNAGE

- A. Install instructional sign in each electrical room including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.
- B. Apply warning, caution, and instruction signs and stencils as follows:
 1. Install warning, caution or operating instruction signs where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install fiberglass signs or outdoor items.
 2. Emergency Operating Signs: Install engraved laminate signs with white legend on red background with minimum 3/8-inch-high lettering for emergency instructions on power transfer, load shedding or other emergency operations where required by NEC or where required to assure safe operation and maintenance.
 3. Arc Flash Hazard Warning: Provide signage on all electrical equipment such as switchboards, panelboards, industrial control panels, meter socket enclosures and motor control centers indicating arc flash hazard warning and advising appropriate PPE.

3.09 FLOOR TAPE

- A. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

3.10 ELECTRICAL EQUIPMENT IDENTIFICATION

- A. On each unit of equipment, install unique designation label that is consistent with wiring diagrams, one-line diagram, schedules and the Operation and Maintenance Manual. Each section of a multiple-section equipment lineup shall be provided with its own identification label. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets and racks of each system. Systems include power, lighting, control, communication, signal, monitoring and alarm systems unless equipment is provided with its own identification.
- B. Labeling Instructions:
 - 1. Indoor Equipment: Provide self-adhesive, engraved, laminated acrylic or melamine label
 - 2. Outdoor Equipment: Provide engraved, laminated acrylic or melamine label.
 - 3. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
 - 4. Nameplate Data: Provide permanent operational data nameplate on each item of power operated equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances and similar essential data. Locate nameplates in an accessible location.
 - 5. Service Disconnects: Provide permanent engraved sign with 2-1/4-inch-high black lettering on white background clearly describing the location of all other service disconnecting means (including engine generator sources and central battery systems) when the building is served by more than one source of electrical power. Locate signs at each power source's disconnect means.
 - 6. Outdoor Electrical Equipment: Provide outdoor Pictogram type sign per above specifications, with the words "DANGER - HIGH VOLTAGE Hazardous Voltage. Will shock burn, or cause death. KEEP OUT." NEMA Mr. Ouch symbol shall be included. Install at all entrances to outdoor areas and every 20 feet along area fences, with at least one sign per side of fencing. Install on doors to equipment.
 - 7. Fusible Switches: Install fuse manufacturer-supplied labels inside the door of the fusible switch indicating the proper type and fuse required for replacement.
 - 8. Automatically Started Equipment: Provide adhesive label reading "DANGER - WARNING THIS MACHINE IS AUTOMATICALLY CONTROLLED. IT MAY START AT ANY TIME" on all motors, generators and other moving or hazardous equipment which is remotely or automatically operated. Sign to be similar to Brady Number 88191.
- C. Specific Equipment Requirements:
 - 1. Power Distribution Equipment: Including, but not limited to switchgear, switchboards, distribution panelboards, branch panelboards and motor control centers.
 - a. Identification label shall include the following:
 - 1) Equipment type and tag designation shown on the contract documents using 1/2-inch-high bold lettering.
 - 2) Voltage and phase rating of the equipment using 1/4-inch-high bold lettering.
 - 3) The name of the upstream equipment and location/room number it is located in using 1/4-inch-high bold lettering.
 - 4) Rating and type of overcurrent protection device serving the equipment (e.g., "FED FROM 200A/3P CIRCUIT BREAKER") using 1/4-inch-high bold lettering.
 - b. Example Identification Label:

DISTRIBUTION PANEL 'DP1'

208Y/120V 3-Phase 4-Wire
Fed from Panel MP1; Room 200
Fed from 200A/3P Circuit Breaker

- c. A separate nameplate shall be provided at the service entrance equipment for all sources of power indicating the maximum available fault current and the date the fault current calculation was performed.
 - d. Distribution panelboards and switchboards shall be provided with permanent labeling adjacent to each overcurrent protection device indicating the load being served and the location of the equipment.
 - e. A typewritten directory of circuits shall be provided at all branch panelboards. Provide explicit description and identification of items served by each individual switch and circuit breaker.
2. Transformers:
- a. Identification label shall include the following:
 - 1) Equipment type and tag designation shown on the contract documents in 1/2-inch-high bold lettering.
 - 2) Voltage and phase rating of equipment using 1/4-inch-high bold lettering.
 - 3) The name of the upstream equipment and location/room number it is located in using 1/4 inch high bold lettering.
 - 4) Rating and type of overcurrent protection device serving the equipment (e.g., "FED FROM 70A/3P CIRCUIT BREAKER") using 1/4 inch high bold lettering.
 - b. Example Identification Label:

TRANSFORMER 'T1'

480 Δ :208Y/120V 75kVA
Fed from Panel DP1; Room 200
Fed from 125A/3P Circuit Breaker

3. Control Equipment: Including but not limited to disconnect switches, starters, variable-speed controllers, contactors, motor control centers, pushbutton stations, etc.
- a. Identification label shall include the following:
 - 1) Equipment type and tag designation shown on the contract documents of the actual equipment served in 1/2-inch-high bold lettering.
 - 2) Location of equipment being served in 1/4-inch-high bold lettering. If the equipment being served by the control equipment is located in the same room, identify location as "THIS ROOM."
 - 3) Voltage and phase rating of equipment in 1/4-inch-high bold lettering.
 - 4) The name of the upstream equipment and location/room number it is located in using 1/4-inch-high bold lettering.
 - b. Example Identification Label:

AHU-6 Supply Fan 'AHU-6S'

Located in Mechanical Room 001
480V 3-Phase, 3 Wire
Fed from Distribution Panel MHEQ; Room 200

4. Power Transfer Equipment.
- a. Identification label shall include the following:

- 1) Equipment type and tag designation shown on the contract documents in 1/2-inch-high bold lettering.
 - 2) The power branch the power transfer equipment serves (e.g., CRITICAL, LIFE SAFETY, EQUIPMENT, NORMAL) in 1/2-inch-high bold lettering.
 - 3) Voltage, phase rating and pole quantity of equipment using 1/4-inch-high bold lettering.
 - 4) The name of upstream equipment and location/room number it is located in using 1/4-inch-high bold lettering. Differentiate upstream sources by indicating Normally Closed (NC) and Normally Open (NO). If the upstream equipment supplying power is located in the same room as the power transfer equipment, identify location as "THIS ROOM."
 - 5) The name of the downstream equipment and location/room number it is located in using 1/4-inch-high bold lettering. If the downstream equipment being served is located in the same room as the power transfer equipment, identify location as "THIS ROOM."
- b. Example Identification Label:

AUTOMATIC TRANSFER SWITCH 'ATS-C1'
CRITICAL POWER
480Y/277V 3-Phase, 4-Wire, 4-Pole
Upstream Source (NC): Fed from Panel 'SB-1'; Room 200
Upstream Source (NO): Fed From Panel 'SB-GP'; Room 201
Downstream: Feeds Distribution Panel 'DP-C1'

END OF SECTION

THISPAGELEFT INTENTIONALLY BLANK

**SECTION 26 0573
POWER SYSTEM STUDIES**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes computer-based, fault-current analysis and report, overcurrent protective device coordination study and arc flash hazard analysis and report.
 - 1. Electrical service fault current calculation labeling shall be provided based upon the results as required in NFPA 70 Article 110.24.
 - 2. Protective devices shall be set based on results of the protective device coordination study.
 - 3. Arc flash labeling shall be provided based upon results of arc flash analysis Study per the requirements set forth in the current issue of NFPA 70E-Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE Standard 1584-2002, the IEE Guide for Performing Arc-Flash Calculations.
- B. The scope of the studies shall include the entire electrical system proposed within the contract documents.
- C. The scope of the studies shall include the electrical distribution equipment as identified by the Owner.

1.03 SUBMITTALS

- A. Product Certificates: For coordination-study, fault-current-study, and arc flash hazard calculation computer software programs, certifying compliance with IEEE 399.
- B. Qualification Data: For coordination-study specialist:
 - 1. The power system studies shall be performed based upon the contract documents and shall include the specific equipment, settings, and performance to be provided and estimated conductor lengths.
- C. Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. A preliminary Arc Flash Hazard analysis shall be submitted to the Owner's Representative no later than six (6) weeks after the overcurrent protective device shop drawings have been approved.
 - 1. Documentation shall be provided in a report format, contained within a bound booklet or three-ring binder. Individual studies shall be separated with identification labels. Shop drawings shall be provided for all overcurrent protective devices in a separate section of the same document.
 - a. The report shall include the following sections:
 - 1) Executive Summary including Introduction, Scope of Work and Results/Recommendations.
 - 2) Short-Circuit Methodology Analysis Results and Recommendations.
 - a) Fault current calculations shall be provided for both utility fault current contributions and on-site standby-power generation fault current contributions. Calculation input data shall be provided including fault current contributions. Fault current calculations shall be submitted in both report form and plotted one-line diagrams.
 - 3) Short Circuit Device Evaluation Table.
 - 4) Protective Device Coordination Methodology Analysis Results and Recommendations.

- a) This section shall include Coordination Study input data, including completed computer program input data sheets.
- 5) Protective Device Settings Table.
- 6) Time-Current Coordination Graphs and Recommendations.
- 7) Arc Flash Hazard Methodology Analysis Results and Recommendations.
 - a) This section shall include the details of the incident energy and flash protection boundary calculations, along with Arc Flash boundary distances, working distances, Incident Energy levels and Personal Protection Equipment Levels. The arc flash calculation results should consider and evaluate all possible power source scenarios (utility power source, emergency power source, main-tie-main configurations, etc.) and alternate temporary circuit breaker settings (maintenance mode).
- 8) Arc Flash Labeling.
 - a) This section shall include descriptive information as well as typical label images for the types of labels to be provided.
- 9) Computer Generated One-Line Diagram of the Electrical System.
 - a) The One-Line diagram must clearly identify individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location, device numbers used in the time-current coordination analysis and other information pertinent to the computer analysis.
2. Power system study project model and results shall be submitted on electronic media for use by the Owner. Electrical model information shall include complete coordination files including all device curves. (If using the SKM PowerTools program, Project - Backup shall be used to provide all project electrical model information.)
3. Calculations and analysis shall include the stamp or seal and signature of the preparing Registered Professional Electrical Engineer and shall be reviewed and approved by the Engineer of Record.

1.04 QUALITY ASSURANCE

- A. Studies shall use computer programs defined in this specification. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
- B. Coordination Study Specialist Qualifications: An entity experienced in the application of computer software used for studies having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 1. Engineering Firm: The approved Engineering firm shall have a minimum of fifteen (15) years' experience in performing power system studies.
 2. Professional Engineer: The Registered Professional Engineer shall be licensed in the state where Project is located and will be responsible for the studies. All elements of the studies shall be performed under the direct supervision and control of the Registered Professional Engineer.
- C. Provide products and installation methods specified in this section that comply with the following Standards:
 1. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
 2. Comply with IEEE 399 for general study procedures.
 3. Comply with IEEE 1584 and NFPA70E-2009/2012 for arc flash hazard analysis.

PART 2 - PRODUCTS

2.01 COMPUTER SOFTWARE DEVELOPERS

- A. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:
 - 1. SKM Systems Analysis, Inc. Power Tools for Windows (PTW).

2.02 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 399.
- B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable" and "desirable" features as listed in IEEE 399.
- C. 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.
- D. Analysis shall include software capable of calculating arc flash hazard and preparing arc flash hazard labels.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings, in the Specifications, by the Owner, and as required by the applicable edition of the National Electrical Code NFPA 70.
 - 1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.
 - 2. The short circuit, overcurrent protective device coordination analysis and fault hazard calculations shall be based upon a complete electrical model of the electrical system from the utility service through the entire building's electrical distribution system, including branch circuit and lighting panelboards, motor control centers, individual motor control devices, motor disconnect switches and distribution panelboards.

3.02 POWER SYSTEM DATA

- A. Gather and tabulate the following input data to support coordination study:
 - 1. Product Data for overcurrent protective devices specified in other Division 26 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. Impedance of utility service entrance.
 - 3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
 - a. Circuit-breaker and fuse-current ratings and types.
 - b. Relays and associated power and current transformer ratings and ratios.
 - c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
 - d. Generator kilovolt amperes, size, voltage, and source impedance.
 - e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
 - f. Busway ampacity and impedance.
 - g. Motor horsepower and code letter designation according to NEMA MG 1.

- B. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram showing the following:
 - 1. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - 2. Transformer characteristics, including primary protective device, magnetic inrush current and overload capability.
 - 3. Motor full-load current, locked rotor current, service factor, starting time, type of start and thermal-damage curve.
 - a. Generator thermal-damage curve.
 - b. Ratings, types, and settings of utility company's overcurrent protective devices.
 - c. Special overcurrent protective device settings or types stipulated by utility company.
 - d. Time-current-characteristic curves of devices indicated to be coordinated.
 - e. 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.
 - f. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range and current transformer ratio for overcurrent relays.
 - g. Panelboards, switchboards, motor-control center ampacity and interrupting rating in amperes rms symmetrical.

3.03 SHORT CIRCUIT CURRENT STUDY

- A. Calculate the maximum available short-circuit current in Amperes (RMS, Symmetrical) from the utility service to and including circuit-breaker positions of the electrical power distribution system shown on the drawings.
- B. Transformer design impedances shall be used when test impedances are not available.
- C. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at the main bus of all switchgear, switchboards, distribution panelboards, branch panelboards, motor control centers, motor controllers (including variable frequency drives) and disconnect switches
- D. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
- E. Calculate momentary and interrupting duties on the basis of maximum available fault current.
- F. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with the latest edition of the following:
 - 1. IEEE 602 – Recommended Practice for Electric Systems in Health Care Facilities
- G. Study Report:
 - 1. Input Data: The study shall include input circuit data including electric utility system characteristics, source impedance data, conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedances and X/R ratios, motor contributions and other circuit information as related to the short-circuit calculations.
 - 2. One-Line Diagram: Documentation shall be made in one-line diagram form showing the magnitude and location of each calculated fault. A summary of the fault currents available shall also be submitted.
 - 3. Calculations: Provide tabulated form of calculated quantities including short-circuit currents, X/R ratios, equipment short-circuit interrupting or withstand current ratings and notes regarding adequacy or inadequacy of the equipment ratings.
 - 4. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.

5. Provide a comprehensive discussion section evaluating the adequacy or inadequacy of the equipment and include recommendations as appropriate for improvements to the system.
6. Contractor shall notify the Owner in writing of any circuit protective devices improperly rated for the calculated available fault current.

3.04 OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

- A. Perform coordination study using approved computer software program. The analysis shall include comparing time/current curves of primary protective devices, service and distribution transformers, main service overcurrent protective devices, switchgear, switchboard, motor control center, distribution panelboard, panelboards, and branch feeder devices.
 1. Where applicable, the analysis shall include the standby and emergency power system components, including the standby power source fault currents and overcurrent device operations.
 2. Terminate device characteristics curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
 3. The protective device settings shall address the need to minimize arc flash hazards while maintaining proper coordination.
- B. Comply with recommendations for fault currents and time intervals dictated within the latest edition of the following:
 1. IEEE 602 – Recommended Practice for Electric Systems in Health Care Facilities
- C. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482 and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- D. Selective Coordination Analysis
 1. Provide a complete selective coordination analysis, comparing time/current curves of the protective devices to be installed to assure complete selectivity between main and downstream devices for code-required branches and branches identified specifically on the one-line diagram.
 2. Provide settings of protective devices to assure complete selectivity between devices as indicated below and as required by Code while providing proper protection.
- E. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
 1. One-Line Diagram: Provide a one-line diagram which clearly identifies individual equipment buses, bus numbers, protective device identification numbers and the maximum available short-circuit current at each bus when known.
 2. Tabular Format of Settings Selected for Overcurrent Protective Devices: Provide a separate tabular printout containing the type and recommended settings of all adjustable overcurrent protective device parameters, the equipment designation where the device is located, and the device number corresponding to the device on the system one-line diagram.
 3. Coordination Curves: Prepare log-log scale graphs using time-current curves to determine settings of series connected 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. Identify the device associated with each curve by device identification tag, manufacturer type, function and, if applicable, tap, time delay and

instantaneous settings recommended. In addition, include the following information on the time-current curve graphs, where applicable:

- a. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands.
 - b. Ground fault protective devices.
 - c. Pertinent motor starting characteristics and motor damage points.
 - d. Pertinent generator short-circuit decrement curve and generator damage point.
 - e. The largest feeder circuit breaker or fuse in each motor control center and applicable panelboard.
4. Include time current curves for both the phase and ground fault settings for each overcurrent protective device including device set points.
 5. Completed data sheets for setting of overcurrent protective devices.
- F. The Contractor shall notify the Owner in writing of any significant deficiencies in protection and/or coordination, along with recommendations for improvements.

3.05 ARC FLASH HAZARD ANALYSIS

- A. Arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2009, Annex D after completion of settings for all overcurrent protective devices in the electrical model and calculation of the maximum available fault currents at each bus.
- B. Arc flash hazard analysis shall calculate the flash boundary and incident energy at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.
- C. Exclude any equipment rated 240V ac or less fed from step down transformers less than 125 kVA.
- D. Safe working distances shall be based on IEEE 1584. The calculated arc flash protection boundary shall be determined using those working distances.
- E. Arc flash PPE level shall not exceed 2 at any electrical bus or main protective device.
- F. The fault calculations and resulting arc flash hazard calculation results shall be compared for multiple scenarios to determine the greatest incident energy for each equipment location. Calculations shall be performed at both maximum and minimum fault currents, and for scenarios where system is operating based upon utility or standby power sources.
 1. A minimum calculation shall assume the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off).
 2. A maximum calculation will assume a maximum contribution from the utility and will assume the maximum about of motors to be operating.
 3. Where applicable, calculations must take into consideration the parallel operation of synchronous generators with the electric utility source.
- G. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices shall be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.
- H. The 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 should be decremented as follows:
 1. Fault contribution from induction motors should not be considered beyond 3 to 5 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 3 per unit after 10 cycles).

- I. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.
- J. When performing incident energy calculations on the line side of a main breaker (as required per the above), the line side and load side contributions must be included in the fault calculation.
- K. Incoordination should be checked among all devices within the branch containing the immediate protective device upstream of the calculation location, and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.
- L. Arc flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002.
- M. Where it is not physically possible to move outside the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.
- N. Create and install NFPA 70E compliant labels describing the arc flash hazard level at all switchboards, panelboards, disconnect switches and other locations in the electrical distribution system where work could be performed on energized parts.
 - 1. The label shall include worst-case incident energy calculated in the analysis and the hazard category or appropriate personal protective equipment (PPE) required to perform maintenance on the system when energized, the available short circuit current at the equipment, the study report number, and the date the calculations were performed. Labels shall be waterproof vinyl or laminated, with a self-adhesive backing.
 - 2. Provide labels on the front of each individual section of floor standing and wall mounted equipment.
 - 3. Install labels on the front of each individual section of floor standing and wall mounted equipment.
- O. A list of all hazard categories and the corresponding PPE requirements shall be posted in the main electric room, engineering office or other location. The list shall be plastic laminate or typewritten and housed in a plastic frame.
- P. Contractor shall submit the following:
 - 1. Results of the Arc-Flash Hazard Analysis in tabular form, Include device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, working distances, personal-protective equipment classes and Arc Flash Incident Energy Levels. Report shall clearly indicate which analysis scenario yielded the worst-case result.
 - 2. Report incident energy values based on recommended device settings for equipment within the scope of the study.
 - 3. Recommendations to reduce Arc Flash Incident Energy Levels and enhance worker safety, where applicable.

3.06 ADJUSTMENTS

- A. Manufacturer's authorized representative or Contractor shall set all adjustable protective devices to values indicated in the approved coordination study.
- B. The Contractor shall make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.
- C. The Short Circuit Study, Coordination Study and Arc Flash Hazard Analysis shall be reviewed and updated to reflect any changes and corrections to conductor length within one week of the final electrical walk through for punch list.

3.07 TRAINING

- A. Provide two hours of Owner training of arc flash hazard risks and labeling.

END OF SECTION

SECTION 26 0600
ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Electrical coordination, materials and methods for electrical demolition associated with remodeling of an existing area or facility for re-use.

1.03 SELECTIVE DEMOLITION

- A. This Section includes limited scope general construction materials and methods for application with electrical installations as follows:
- B. Selective demolition including:
 - 1. Nondestructive removal of materials and equipment for reuse or salvage as indicated.
 - 2. Dismantling electrical materials and equipment made obsolete by these installations.
 - 3. Miscellaneous metals for support of electrical materials and equipment required to remain.
 - 4. Firestopping as required to maintain existing partition ratings.

1.04 PROJECT CONDITIONS

- A. Conditions Affecting Selective Demolition: The following project conditions apply:
 - 1. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
 - 2. Locate, identify, and protect electrical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.
 - 3. Maintain and protect existing building services that transit the area affected by selective demolition.

1.05 SEQUENCE AND SCHEDULING

- A. Coordinate the shut-off and disconnection of electrical, fire alarm and communication services with the Owner and the utility companies. Coordinate any electrical outages required for service switchovers or connections with the Owner a minimum of five working days prior to the interruption. Comply with Owner's specific requirements for partial or complete outage requests.
- B. All work that produces excessive noise and/or interference with normal building operations, as indicated on the drawings, shall be coordinated, and scheduled with the Owner.
- C. Assume that all required re-connection of existing systems or equipment not indicated for demolition must remain operational unless otherwise noted. Provide temporary connections to maintain electrical services and systems serving adjacent areas during required outages.
- D. Maintain existing electrical service, electrical distribution, fire alarm and communication equipment in operation until the new electrical service or distribution equipment is energized, tested, and accepted.

1.06 DRAWINGS AND SPECIFICATIONS

- A. The architectural, structural, mechanical and electrical drawings and specifications shall be considered as mutually explanatory and complementary. Any electrical demolition work called for by one and not by the other shall be performed as though required by all. All sections and

subsections of the Electrical work shall be governed by and subject to the general and supplementary conditions. Any discrepancies in or between the drawings and specifications, or between the drawings and actual field conditions shall be reported to the Engineer/Architect in sufficient time to issue an addendum for clarification.

- B. The electrical drawings are diagrammatic and the drawings indicate the general layout of the electrical systems. Field verification of scale dimensions on plans is directed since actual locations, distance and levels will be governed by actual field conditions.

PART 2 - PRODUCTS

2.01 MATERIALS AND METHODS

- A. Materials and methods required for removing, patching, connections, etc., shall be as specified in the associated specification sections.

PART 3 - EXECUTION

3.01 COMMON REQUIREMENTS FOR ELECTRICAL DEMOLITION

- A. Comply with NECA 1.

3.02 EXAMINATION AND COORDINATION

- A. Examine substrates, areas and conditions with Installer present for compliance with requirements for conditions affecting demolition.
- B. Coordinate the demolition scope of work with the Owner and other Contractors to confirm that all required electrical demolition is addressed and scheduled to avoid disputes.

3.03 SELECTIVE DEMOLITION

- A. The Electrical Contractor shall remove, cap and/or relocate equipment, outlets, conduit, wire, etc., as shown and specified on drawings and as may become necessary because of existing field conditions. It shall be the responsibility of the Electrical Contractor to visibly examine all existing walls designated for removal to determine the conduit and the wiring that will require capping and/or removal, whether or not such conditions are indicated on the drawings. The contractor shall be held to having visited the site and taken all existing conditions into consideration.
- B. Where the architectural drawings indicate that partitions, walls, ceilings, etc., are to be removed the Electrical Contractor shall be responsible for removal of all electrical components within those structures including equipment, lighting fixtures, lighting controls, wiring devices, raceways, wiring, electrical systems, etc.
- C. In addition to the foregoing, comply with the following:
 - 1. Maintain circuit continuity to all existing fixtures, equipment, outlets, etc., to remain in use whether noted on the plans or not. Field-verify existing items to remain in use. Wiring for existing circuits which must be re-routed, or which are partially abandoned, shall be reconnected to service the remaining outlets on the circuit.
 - 2. In the demolition work, remove all unused wiring and cables and unused conduit that is exposed or within accessible ceilings which is affected by and is in the area of the work of this contract.
- D. The intention of the electrical demolition drawings is to disconnect and remove all electrical work made void by the scope of the construction and alteration. Field-verify exact material quantities required to be removed.
- E. Abandoned electrical power distribution equipment, including switchboards, motor controllers, panelboards, lighting fixtures and controls and wiring devices shall be disconnected and removed unless otherwise noted. All supporting equipment for this equipment to be removed, including hangers, supporting rods, ballasts, etc., shall be removed.

- F. All existing electrical work and associated raceway and wiring, which has been made obsolete by the work and/or is shown dashed on the electrical demolition drawings shall be disconnected and removed back to the source of power unless otherwise noted. Although an attempt has been made to indicate all of this work, total accuracy is not guaranteed. Contractor shall visibly examine all areas and walls and ceilings scheduled for removal to determine existing electrical items to remain.
- G. Where electrical equipment, conduit, boxes and supporting hardware are removed, patch and finish the surface as required to match the existing unless otherwise noted.
- H. All removed materials, other than removed materials to be relocated, or stored or turned over to the Owner shall become the property of the Contractor and shall be removed from the project site.
- I. Acceptance of contract means installer accepts existing conditions.
- J. Contractor shall coordinate all demolition work with all other trades.
- K. In walls or floors where a flush device is being removed, but the wall or floor remains or for any outlet which must remain, but has a device removed, provide a blank cover over the outlet. Match the color and material of existing remaining covers in the room or space.
- L. In areas where the partitions, ceilings, etc., are indicated to be temporarily removed, the Electrical Contractor shall be responsible for the disconnection, storage, re-installation and re-connection of equipment or devices within that partition, ceiling, etc., unless otherwise noted.
- M. Legally dispose of hazardous materials and ballasts or other equipment containing PCBs and lamps containing mercury or equipment containing oil. Comply with all Federal, state, and local laws. This includes HID and fluorescent lamps determined to be hazardous waste. These shall be disposed of at a permitted hazardous waste disposal facility or other appropriately permitted entity.
- N. Provide manifests and travel and disposal forms and documents to Owner when required by Owner or regulatory agencies.

3.04 CLEANING

- A. Clean existing electrical distribution equipment affected by the project, including switchboards, motor controllers, panelboards, etc. Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide coverplates for openings. Modify existing panelboard directories (or replace) for panelboards which have had alterations to the circuits originating therein. Describe the load and location.
- B. Where luminaires are indicated to be retained and re-used, the Electrical Contractor shall clean all exterior and interior surfaces. Lamps and ballasts shall be replaced with new. Broken electrical parts, including guards and lens shall be replaced to match existing construction unless otherwise noted.

3.05 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical demolition to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION

THISPAGELEFT INTENTIONALLY BLANK

SECTION 26 0923
LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Occupancy sensors.
- B. Related Requirements:
 - 1. Section 26 2726 "Wiring Devices" for wall-box dimmers, and manual light switches.

1.03 SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show installation details for occupancy and light-level sensors.
- C. For products used in lieu of basis of design, submit a lighting plan clearly marked by manufacturer showing proper product, location and orientation of each sensor.
- D. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

1.04 QUALITY ASSURANCE

- A. Products supplied shall be from a single manufacturer that has been continuously involved in manufacturing of lighting controls for a minimum of five (5) years. Mixing of manufacturers shall not be allowed.
- B. All components shall be U.L. listed, offer a five (5) year warranty and meet all state and local applicable code requirements.
- C. All occupancy sensors shall be tested to NEMA WD 7-2011 Occupancy Motion Sensors Standard.

1.05 COORDINATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including luminaires, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

PART 2 - PRODUCTS

2.01 INDOOR OCCUPANCY SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide as listed per each sensor type or comparable product by one of the following:
 - 1. Cooper Industries, Inc.
 - 2. Hubbell Building Automation, Inc.
 - 3. Acuity Brands Lighting, Inc.
 - 4. Lutron Electronics Co., Inc.
- B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.
 3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
 4. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 5. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
 7. Bypass Switch: Override the "on" function in case of sensor failure.
 8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux); turn lights off when selected lighting level is present.
- C. Ceiling Sensor Type: Ceiling mounted; detect occupants in coverage area using PIR detection methods. All sensors tested per NEMA WD7 standards. PIR is the only acceptable technology. (WattStopper LMPC-100)
1. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 square inches (232 square cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inch/es (305 mm/s).
 2. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 square feet (93 square m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 3. Normally open/normally closed contacts available for 3rd party integration.

2.02 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide as listed per sensor type or comparable product by one of the following:
1. Cooper Industries, Inc.
 2. Hubbell Building Automation, Inc.
 3. Acuity Brands Lighting, Inc.
 4. Lutron Electronics Co., Inc.
- 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 degrees F (0 to 49 degrees C).
 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 OD:
1. Standard Range: 180-degree field of view, with a minimum coverage area of 10 feet x 15 feet.
 2. Sensing Technology: Dual-technology.

3. Switch Type: field selectable automatic "on," or manual "on," automatic "off."
4. Voltage: Dual voltage, 120 and 277 V
5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
6. Concealed, field-adjustable, "off" time-delay selector between 1 and 30 minutes.

2.03 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 26 0519 "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 26 0519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.01 SENSOR INSTALLATION

- A. 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.
- B. 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. Ultrasonic sensors to remain minimum of 6 feet from supply air.

3.02 WIRING INSTALLATION

- A. Wiring Method: Comply with Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch (13 mm).
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.03 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 26 0553 "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.

3.04 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections.
 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.
 3. Verify occupancy sensors operate per design intent.
- B. Lighting control devices will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.05 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors 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.

3.06 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION

SECTION 26 2416
PANELBOARDS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Lighting and appliance branch-circuit panelboards.

1.03 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to Section 20 0800 "Seismic Protection."

1.04 SUBMITTALS

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory and component indicated. 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. Show tabulations of installed devices, equipment features and ratings such as voltage, main bus ampacity, integrated short circuit ampere rating, overcurrent protective device arrangement and sizes.
 - 2. Include short-circuit current calculation results to show the short-circuit current rating for this equipment exceeds the available short-circuit fault current available. Refer to specification 26 0573.
 - 3. Include overcurrent protective device study to show all essential electrical systems, emergency systems and legally required standby system protective devices coordinate with upstream and downstream overcurrent protective devices to the code required interval, or specific interval indicated. Refer to specification 26 0573.
 - 4. Include manufacturer's selective coordination tables indicating coordination between the main and branch circuit breakers. The main breaker and branch breakers being provided shall be clearly labeled on the tables.
- C. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 20 Section "Seismic Procedures."

1.05 QUALITY ASSURANCE

- A. Source Limitations: Obtain panelboards, overcurrent protective devices, components and accessories from single source from single manufacturer.
- 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 "Panelboards."
- E. Comply with NFPA 70 "National Electrical Code."

1.06 COORDINATION

- 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.

1.07 WARRANTY

- A. Warranty: Panelboard and components shall be warranted to be free from manufacturing defects for a period of one year after project acceptance by Owner.

1.08 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Keys: Two spares for each type of panelboard cabinet lock.
 - 2. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 20 Section "Seismic Protection."
- B. Enclosures: NEMA PB 1, Type 1, flush or surface mounted as shown on drawings.
 - 1. Rated for environmental conditions at installed location, unless otherwise noted on drawings, the following types shall be used in the listed locations:

Location	NEMA Type
Dry, clean indoor	NEMA 1
Outdoor or Damp or wet interior locations	NEMA 3R
Indoor or outdoor corrosive areas or areas subjected to hose streams	NEMA 4X
Dusty indoor areas	NEMA 12

- 2. Finishes:
 - a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Same finish as panels and trim.
- 3. Directory Card: Inside panelboard door, mounted in transparent card holder.
- C. Phase, Neutral, and Ground Buses:
 - 1. Material: Copper.
 - 2. Main bussing shall be fully rated, non-tapered, ready to receive those overcurrent devices indicated as spaces without modifying the bus. Neutral bus to be rated at 100 percent of the main bus rating, capable of accepting terminations based on the maximum number of branch circuit protective devices allowed in the panelboard plus 6 additional conductors.
 - 3. Equipment Ground Bus: Adequate for panelboard feeder and branch-circuit equipment ground conductors. Equipment ground bus shall be large enough and have sufficient

quantity and sizes of terminations to allow for termination of panelboard feeder plus one equipment-grounding conductor per circuit, based on the maximum number of branch circuit protective devices allowed in the panelboard plus 6 additional conductors. Increase terminations to accommodate additional feeder conductors where double-lugged panelboards are indicated. When panelboards are multiple sections, provide equipment ground busses in each section of sufficient size for all grounding conductors in that section. Ground busses to be insulated from the panelboard enclosure where isolated ground busses are called for. Ground busses shall be bonded to enclosure when isolated ground busses are not called for.

- D. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Main, Neutral, and Ground Lugs and Buses: Provide mechanical connectors for conductors. Provide necessary additional wire bending and terminating space when sub-feed and feed-through lugs are called for.
- E. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.
- F. Future Devices: Mounting brackets, bus connections, filler plates and necessary appurtenances required for future installation of devices.
- G. Overcurrent Protection Devices: Multiple pole overcurrent protection devices shall be provided with a common trip handle for all poles. Tandem circuit breakers are not allowed.
- H. Panelboard Short-Circuit Current Rating: All distribution and branch circuit panelboards shall be fully rated to interrupt symmetrical short circuit current available at terminals. Series rated equipment is not allowed.

2.02 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- 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. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Doors: Hinged front cover, entire front trim hinged to box and with standard door within concealed hinged trim cover (door-in-door). Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Provide flush locks, keyed alike.
- D. Interiors: Provide physical means to prevent installation of more overcurrent protection devices than the quantity for which the enclosure was listed. Interiors shall be field convertible for top or bottom feed.
- E. Box: Box shall be nominally 5-3/4 inches deep by 20 inches wide.
- F. Circuit Numbering: Provide factory fabricated circuit numbers adjacent to each circuit breaker pole position. Numbering shall be continuous from topmost pole position to last possible pole position. Number sequence on left shall be 1-3-5-7, etc., and number sequence on right shall be 2-4-6-8, etc. Numbering material shall be insertable or strip type, as manufactured by the panelboard manufacturer for the specific panelboard. Adhesive markers and pen type markers are not acceptable.
- G. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Circuit Breakers: Provide molded-case, thermal-magnetic, trip-free, bolt-on circuit breakers (unless otherwise noted) replaceable without disturbing adjacent units. Circuit breaker escutcheon shall have ON and OFF markings. Circuit breaker handle accessories shall provide provisions for locking handle in the "ON" or "OFF" position. Circuit breaker faceplate and handle shall indicate rated ampacity. Circuit breaker faceplate shall indicate UL certification standards with applicable voltage systems and corresponding AIC ratings. Circuit breakers 30 amperes and less shall be UL listed to accept copper conductors with insulation rated at 60, 75 and 90 degrees Celsius, with conductors sized from the 60-degree Celsius column of Table 310.15(B)(16) of the NEC. Circuit breakers larger than 30 amperes shall be UL listed to accept copper conductors with insulation rated at 75 or 90 degrees Celsius with conductors sized from the 75-degree Celsius column of Table 310.16 of the NEC.
 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits; Type HACR for feeding heating, air conditioning or refrigeration loads. Provide UL Class A ground fault interrupter circuit breakers where scheduled on drawings. Arc fault circuit breakers shall comply with UL 1699; 120/240-V, single-pole configuration.
- H. Short Circuit Rating: Provide short circuit rating for each panelboard as indicated on drawings. Ratings indicated are minimum values. Manufacturer shall provide the next larger rating if the value indicated is unavailable.

2.03 LOAD CENTERS

- 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. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.
- B. Load Centers: Comply with UL 67.
- C. Doors: Provide lock on door.
- D. Branch Overcurrent Protective Devices: Plug-in circuit breakers, integral thermal and instantaneous magnetic trip with common trip handle for all poles, replaceable without disturbing adjacent units.
1. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent lighting circuits; Type HACR for feeding heating, air conditioning or refrigeration loads. Provide UL Class A ground fault interrupter circuit breakers where scheduled on drawings. Arc fault circuit breakers shall comply with UL 1699; 120/240-V, single-pole configuration.
- E. Conductor Connectors: Mechanical type for main, neutral and ground lugs and buses.
- F. Short Circuit Rating: Provide short circuit rating for each panelboard as indicated on drawings. Ratings indicated are minimum values. Manufacturer shall provide the next larger rating if the value indicated is unavailable.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- B. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.02 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Comply with mounting and anchoring requirements specified in Division 20 Section "Seismic Protection."
- C. Mounting height: Mount panelboards such that the center grip of any operating handle, when in its highest position, is not more than 79 inches above the floor. Align top edges of panelboard covers where multiple panelboards are installed in the same general area.
- D. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit breaker trip ranges as dictated on drawings within approved selective coordination study.
- E. Fuse Labels: Install pre-printed label from fuse manufacturer inside the cover of each fusible switch indicating the proper replacement fuse.
- F. Install filler plates in unused spaces.

3.03 IDENTIFICATION

- A. Comply with requirements within Division 26 Section "Identification for Electrical Systems."
- B. Circuit Directory: Provide typed circuit directory reflective of final circuit changes. Identify all circuits including spares. Spaces shall be left blank. Circuit designations shall describe the load type and location. For example, "Lighting - North Corridor" or "Receptacles - Rooms A, B, C and X, Y, Z." Use Owner's room designations, not designations shown on the plans, if different. Type on cardboard stock installed behind clear acrylic holder enabling removal of the directory.

3.04 FIELD QUALITY CONTROL

- A. Visual and Mechanical Inspection: Include the following inspections and related work:
 - 1. Inspect for defects and physical damage, labeling and nameplate compliance with requirements of up-to-date drawings and panelboard schedules.
 - 2. Exercise and perform operational tests of all mechanical components and other operable devices in accordance with manufacturer's instruction manual.
 - 3. Check panelboard mounting, area clearances, alignment and fit of components.
 - 4. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
- B. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
 - 1. Measure as directed during period of normal system loading.
 - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 - 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
 - 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

END OF SECTION

THISPAGELEFT INTENTIONALLY BLANK

**SECTION 26 2726
WIRING DEVICES**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Receptacles, receptacles with integral GFCI and associated device plates.
 - 2. Hospital-grade receptacles.
 - 3. Snap switches and wall-box dimmers.

1.03 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

1.04 SUBMITTALS

- A. **Product Data: For each type of product indicated.**

1.05 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.
- B. Comply with NFPA 70.
- C. Comply with UL 498: "Attachment Plugs and Receptacles."
- D. Comply with UL 943: "Ground-Fault Circuit-Interrupters."
- E. Listing and Labeling: Provide products which are listed and labeled by Underwriters Laboratories for their applications and installation conditions and for the environments in which installed.

1.06 COORDINATION

- A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
 - 1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.01 WIRING DEVICES

- A. Comply with NEMA Standard WD 1, "General Purpose Wiring Devices" and NEMA Standard WD6 "Wiring Device Dimensional Requirements."
- B. Enclosures: NEMA 1 equivalent, except as otherwise indicated.
- C. Receptacles, Straight-Blade and Locking Type: Except as otherwise indicated, comply with UL Standard 498, "Electrical Attachment Plugs and Receptacles." Provide UL labeling of devices to verify these compliances. Provide straight blade receptacles per table on the following page.

- D. Any receptacles that are controlled by an automatic control device shall have the centralized receptacle marking furnished with the device or cover plate.
- E. Receptacles and switches having plug tail connectors consisting of a female at the device and a matching male on the pigtail are acceptable provided that that ratings and listings and other portions of this specification apply. The device shall have no exposed parts or wiring when the mating connector is installed.

2.02 STRAIGHT BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Leviton: 5352.
 - b. Cooper: 5352.
 - c. Hubbell: 5352.
 - d. Pass & Seymour: 5362.
- B. Hospital-Grade, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498 Supplement SD.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Leviton: 8300.
 - b. Cooper: 8300.
 - c. Hubbell: HBL8300.
 - d. Pass & Seymour: 8300.
- C. Tamper-Resistant Duplex Convenience Receptacles, 125V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R and UL 498.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Leviton: 5362.
 - b. Cooper: TRBR20.
 - c. Hubbell: BR20.
 - d. Pass & Seymour: TR63.
- D. Hospital Grade, Tamper-Resistant, Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Leviton: 8300SG.
 - b. Cooper: TR8300.
 - c. Hubbell: HBL8300SG.
 - d. Pass & Seymour: TR8300.
- E. Receptacles, Industrial Heavy-Duty: Conform to NEMA Standard PK 4 "Plugs, Receptacles, and Cable Connectors of the Pin and Sleeve Type for Industrial Use" and IEC 309.

2.03 GFCI RECEPTACLES

- A. General Description: Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.
- B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Leviton: GFNT2.
 - b. Cooper: VGF20.
 - c. Hubbell: GF20L.
 - d. Pass & Seymour: 2095.
- C. Weather-Resistant, Duplex GFCI Convenience Receptacles:
 - 1. Products: Subject to compliance with requirements, provide one of the following:

- a. Leviton: GFWR2.
 - b. Cooper: WRVGF20.
 - c. Hubbell: GFTR20.
 - d. Pass & Seymour: 2095WR.
- D. Hospital-Grade, Duplex GFCI Convenience Receptacles, 125 V, 20 A: Comply with UL 498 Supplement SD.
- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Leviton: GFNT2-HF.
 - b. Cooper: HGF20.
 - c. Hubbell: GFR8300HL.
 - d. Pass & Seymour: 2095HG.

2.04 CORD AND PLUG SETS

- A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
- 1. Cord: Rubber-insulated, stranded-copper conductors with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
 - 2. Plug: Male configuration with nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.05 SNAP SWITCHES

- A. Snap Switches: Quiet-type a.c. switches, Underwriters Laboratories listed and labeled as complying with UL Standard 20 "General Use Snap Switches." Switches shall be heavy duty industrial rated, 20A, 120/277V, ivory handle, back and side wired, number of poles as required, with ground screw.
- B. Comply with NEMA WD 1 and UL 20.
- C. Switches, 120/277 V, 20 A:
- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper: AH1221 (single pole), AH1222 (two pole), AH1223 (three way), AH1224 (four way).
 - b. Hubbell: HBL1221 (single pole), HBL1222 (two pole), HBL1223 (three way), HBL1224 (four way).
 - c. Leviton: 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
 - d. Pass & Seymour: 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

2.06 WALL-BOX DIMMERS

- A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
- B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.
- C. Device Enclosures for Outdoor and Other Wet and Damp Locations: Enclosure shall be suitable for wet locations while in use in accordance with Article 406.8 (B) and listed and labeled for the specific use by Underwriters Laboratories. Enclosure shall be clearly and visibly marked by the factory with the wording "Suitable For Wet Locations While In Use." Enclosure shall be non-metallic with hinged clear cover and integral key operated cover lock. Cover to have two exit holes for up to 3/8-inch diameter cords with holes located at bottom of cover. Provide cover with device opening matched to type of wiring device used, e.g., duplex receptacle, GFCI receptacle, and toggle switch.

- D. Color: Match wiring device except as otherwise indicated.

2.07 MULTI-OUTLET ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Hubbell: HBL2000 Series
 2. Wiremold: 2000 Series
 3. Mono-Systems, Inc.: 1900 Series
- B. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
- C. Raceway Material: Metal, with manufacturer's standard finish.
- D. Wire: No. 12 AWG.
- E. Provide receptacle spacing at 12 inches on center.

2.08 FINISHES

- A. Color: Wiring device catalog numbers in Section Text do not designate device color.
1. Wiring Devices Connected to Normal Power System: Ivory, unless otherwise indicated or required by NFPA 70 or device listing.
 2. Wiring Devices Connected to Emergency Power System: Red
 3. TVSS Devices: Blue
 4. Isolated-Ground Receptacles: Orange

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Comply with NECA 1 including the mounting heights listed in that standard, unless otherwise noted.
- B. Coordination with Other Trades:
1. Take steps to ensure that devices and their boxes are protected. 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 the 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. Protect devices and assemblies during painting if installed prior to wall painting.
- C. Conductors:
1. Do not strip insulation from conductors until just 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 all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
 4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
 6. Use a torque screwdriver when a torque is recommended or required by the 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.
 10. Install devices and assemblies plumb and secure.
 11. Install wall plates when painting is complete.
 12. Utilize weather-resistant receptacles in wet or damp locations and outdoors.
 13. For all devices mounted flush in walls where communications backboards are installed, provide extension ring with sufficient depth for the outlet and cover plate to mount flush to the face of the communications backboard. Devices and cover plates that mount recessed to the communications backboard are not acceptable.
 14. Provide GFCI receptacles when installed within 6 ft. of the outside edge of a sink.
- E. Receptacle Orientation:
1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the left.
- 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, multi-gang wall plates.
- I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.02 IDENTIFICATION

- A. Comply with Division 26 Section "Identification for Electrical Systems."

3.03 GROUNDING:

- A. Isolated Ground Receptacles: Connect to isolated grounding conductor routed to designated isolated equipment ground terminal of electrical system.

3.04 FIELD QUALITY CONTROL

- A. Perform 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 LED indicators of measurement.
- B. 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 not acceptable.
 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 and per manufacturer's recommendations.
 5. Test wiring devices for proper polarity and ground continuity. Operate each operable device at least 6 times.
 6. Using the test plug, verify that the device and its outlet box are securely mounted.
 7. The 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.
 8. Replace damaged or defective components.
- C. Test straight blade hospital-grade convenience outlets for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz. (115 g).

3.05 CLEANING

- A. General: Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

END OF SECTION

SECTION 26 2813

FUSES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Fuses.
 - 2. Spare-Fuse Cabinets.

1.03 SUBMITTALS

- A. Submittals for approval by the Engineer are not required for this section. Unrequested submittals will not be processed or reviewed. Non-requirement of submittals is not to be construed as an allowance for substitutions and does not allow relief from full compliance with the contract documents.

1.04 QUALITY ASSURANCE

- A. Source Limitations: All fuses shall be the product of a single manufacturer.
- B. Comply with NEMA FU 1 and NFPA 70.

1.05 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 degrees F (5 degrees C) or more than 100 degrees F (38 degrees C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.06 EXTRA MATERIALS

- A. Spare Fuses: Furnish quantity equal to 1 set of 3 fuses of each fuse type and size installed.
- B. Fuse Pullers: Furnish two.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Bussmann, Inc.
 - 2. Edison Cooper, Inc.
 - 3. Mersen.
 - 4. Littelfuse, Inc.
- B. If other than Bussmann fuses are proposed, submit a table or list indicating the substitution fuse type for each Bussmann type for each family, class, and type. This shall be submitted in the form of shop drawings and shall include manufacturer catalog cuts and descriptive literature or brochures.

2.02 FUSES

- A. Characteristics: NEMA FU 1 nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
- B. Cartridge Fuses: Cartridge fuses shall be as described below and shall have a minimum interrupting rating of 200,000 symmetrical amperes for the a.c. voltage at which they are rated.
 - 1. Fuses rated less than or equal to 200 amperes (not including control circuits): Provide UL class RK-5 fuses.

2. Fuses rated greater than 200 amperes and less than or equal to 600 amperes: Provide UL class RK-1 dual element time delay fuses.
3. Fuses rated above 600 amperes: Provide UL class L dual element time delay fuses.
4. Control circuit fuses: Provide UL class CC (time delay) fuses.
5. Where the Drawings show a specific fuse type, the Drawings shall supersede the above types.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

3.02 INSTALLATION

- A. Install fuses in fusible devices in accordance with manufacturer instructions. Arrange fuses such that label and rating information is readable without removing fuse.

END OF SECTION

SECTION 26 2816
ENCLOSED SWITCHES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Fusible and non-fusible switches.
 - 2. Molded-case circuit breakers.

1.03 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to Division 20 "Seismic Protection."
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.04 SUBMITTALS

- A. Submittals for approval by the Engineer are not required for this section. Unrequested submittals will not be processed or reviewed. Non-requirement of submittals is not to be construed as an allowance for substitutions and does not allow relief from full compliance with the contract documents.
- B. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device. Submit on translucent log-log graph paper.
 - 1. Include selective coordination study to prove all enclosed switches and circuit breakers associated with the essential electrical systems, emergency systems and legally required standby system selectively coordinate with the upstream overcurrent protective devices.

1.05 QUALITY ASSURANCE

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories within same product category from single source and from single manufacturer.
- B. Electrical Component Standards: Provide components complying with NFPA 70 "National Electrical Code" and which are listed and labeled by UL. Comply with UL Standard 98 and NEMA Standard KS 1.

1.06 COORDINATION

- 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.

PART 2 - PRODUCTS

2.01 MANUFACTURERS - GENERAL

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Cutler-Hammer.
 - 2. General Electric.
 - 3. Square D Company.
 - 4. Siemens.

2.02 FUSIBLE AND NONFUSIBLE SWITCHES

- A. General: Provide circuit and motor disconnect switches in types, sizes, duties, features, ratings, enclosures, and accessories as indicated within Disconnect Schedule, located on the drawings.
- B. Fusible and Non-Fusible Switches: Type HD heavy-duty, quick-make, quick-break load interrupter enclosed knife switch, externally operable, lockable handle, interlocked with cover in closed position. Unless indicated otherwise, provide 3-blade with solid neutral when a neutral is provided. Compliant with NEMA KS 1.
- C. Provide positive pressure, reinforced Type Class R fuse clips for fusible switches 600 amps or less to prevent other than UL Class RK current limiting fuses. Provide for Class L fuses for switches over 600A.
- D. Service Switches: Shall be as above but shall also be UL listed for use as service equipment under UL Standard 98 or 869.

2.03 MOLDED-CASE CIRCUIT BREAKERS

- A. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3. Provide circuit breakers in sizes, ratings, enclosures, and accessories as indicated within Equipment Data Schedule or Disconnect Schedule located on the drawings, with interrupting capacity to comply with available fault currents.
- B. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- C. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- D. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing with the following field-adjustable settings:
 - 1. Instantaneous trip.
 - 2. Long- and short-time pickup levels.
 - 3. Long- and short-time time adjustments.
 - 4. Ground-fault pickup level, time delay, and I^2t response.
- E. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller and let-through ratings less than NEMA FU 1, RK-5.
- F. Circuit Breaker Frames Rated 1200 Amperes or Larger
 - 1. Breakers that have a continuous overcurrent trip rating or setting of 1200A or higher shall include:
 - a. Zone-selective interlocking.
 - b. Differential relaying.
 - c. Energy-reducing maintenance switching with local status indicator.
 - d. Energy-reducing active arc flash mitigation system.
 - e. An instantaneous trip setting that is less than the available arcing current.
 - f. An instantaneous override that is less than the available arcing current.
 - g. An approved equivalent means.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install enclosed switches and circuit breakers in locations as indicated level and plumb, according to manufacturer's written instructions. Provide interconnection wiring for control and indication devices where applicable.
- B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- C. Install fuses in fusible disconnect switches such that label and rating information is readable without removing the fuse. Provide permanent label affixed to the inside of the disconnect switch cover indicating the fuse class and size installed.

3.03 IDENTIFICATION

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

3.04 ADJUSTING

- A. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

3.05 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, and abrasions.

END OF SECTION

THISPAGELEFT INTENTIONALLY BLANK

SECTION 26 5100
LIGHTING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Interior luminaires and accessories.
 - 2. Lamps and ballasts.
 - 3. Emergency lighting units and exit signs.
 - 4. Luminaire supports.
- B. Related Sections:
 - 1. SECTION 26 0923 "LIGHTING CONTROL DEVICES" FOR AUTOMATIC CONTROL OF LIGHTING, INCLUDING TIME switches, photoelectric relays, occupancy sensors, digitally addressable lighting control systems, and multi-pole lighting relays and contactors.

1.02 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color-rendering index.
- C. LED: Light Emitting Diode
- D. LER: Luminaire efficacy rating.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting fixture, including ballast housing if provided.
- G. Pole: Luminaire support structure, including tower used for large area illumination.

1.03 SUBMITTALS

- A. For each type of luminaire, arranged in order of luminaire designation. Include complete product model number and product data sheets on features, accessories, finishes, and the following:
 - 1. Physical description of luminaire including dimensions, as well as effective projected area for exterior luminaires.
 - 2. Details of attaching luminaires and accessories.
 - 3. Emergency lighting units including battery and charger.
 - 4. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
 - 5. LED photometric report per latest IESNA LM-79-08 testing guidelines, including luminaire model number, manufacturer of LED chip array/board and driver, input wattage, and independent testing laboratory name, report number, and date tested.
 - 6. Dimmer device data for all LED luminaires specified as dimming. Must be from approved manufacturer per luminaire manufacturer requirements, furnished and installed by contractor. Contractor responsible for dimmer control and luminaire compatibility.
 - 7. Pole information including: Materials, dimensions, finishes, means of attaching luminaire to support, anchor bolts and templates, structural analysis and manufactured pole foundations.
- B. Custom Luminaires: Include plans, elevations, sections, details, and attachments to other work.
 - 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. Wiring Diagrams: For power, signal, and control wiring.

1.04 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. LED Chip Arrays/Boards: 3 for every 100 of each type and rating installed. Furnish at least one of each type.
2. LED Drivers: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
3. Diffusers, Lenses, Globes, and Guards: 2 for every 100 of each type and rating installed. Furnish at least one of each type.
4. Glass and Plastic Lenses: 2 for every 100 of each type and rating installed. Furnish at least one of each type.
5. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

1.05 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products, or by an independent agency complying with the IESNA Lighting Measurements Testing & Calculation Guides.
- B. Comply with IEEE C2, "National Electrical Safety Code" and NFPA 70.

1.06 COORDINATION

- A. Coordinate layout and installation of luminaires and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver luminaire and components to site. Store such that luminaires, finishes, lenses, and trims are protected. Install with protective films on and remove only after construction clean-up is complete.

1.08 WARRANTY

- A. Warranty Period for LED chips/arrays and drivers: 5 years from date of substantial completion.
- B. Warranty Period for Emergency Lighting Unit Batteries, and self-powered exit signs: 5 years from date of substantial completion.
- C. Warranty Period for Luminaires: 5 years from date of substantial completion.
- D. Warranty Period for Poles: 3 years from date of substantial completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Products: Refer to Luminaire Schedule on the drawings.

2.02 GENERAL REQUIREMENTS FOR LUMINAIRES AND COMPONENTS

- A. All luminaires shall carry a UL listing, unless otherwise noted on the Luminaire Schedule. Exterior luminaires shall carry a UL wet location listing as well as designated IP rating, unless otherwise noted on the Luminaire Schedule.
- B. Recessed Luminaires: Housing shall be constructed of steel or aluminum, free of burrs and sharp corners and edges, free of light leakage and accessible without use of tools. Components shall be formed and supported to prevent warping and sagging. Lamp and ballast compartments shall be accessible from below the ceiling.
 1. Lensed troffers shall be provided with hinged door frames and positive spring-loaded latches, UV stabilized acrylic prismatic lenses with a minimum of 0.12 inch thickness, unless otherwise noted on the Luminaire Schedule.

2. Parabolic louvers shall be interlocking low-iridescent, specular anodized aluminum in construction. Number of cells shall be specified on Luminaire Schedule.
 3. Direct/Indirect luminaire lamp chambers shall be made of one-piece perforated steel. Reflectors shall have a minimum reflectance of 90 percent. Both lamp chamber and reflector shall be painted after fabrication.
 4. Volumetric luminaires shall have UV stabilized acrylic lens with optical pattern as designated on Luminaire Schedule. Reflectors shall have a minimum reflectance of 90 percent, painted after fabrication.
 5. Where fire-rated ceilings are specified, luminaires should be provided with listed enclosures meeting requirements to maintain fire-rated system rating.
- C. Suspended Luminaires: Canopies, power feeds, and mounting accessories shall be coordinated with architectural-designated ceiling type. Luminaires shall be installed plumb and level at luminaire height designated on Luminaire Schedule.
- D. Electromagnetic-Interference Filters: Factory installed to suppress conducted electromagnetic interference as required by MIL-STD-461E. Fabricate luminaries with one filter on each ballast indicated to require a filter.

2.03 LIGHT EMITTING DIODE (LED) LUMINAIRE SYSTEMS

- A. Light emitting diodes shall have a minimum color rendering index (CRI) of **80** for interior applications. Refer to Luminaire Schedule for color temperature of the luminaires.
- B. Color changing LED chip arrays shall have chip colors as noted on the Luminaire Schedule.
- C. LED chips shall be wired so that operation of chip array is not prohibited by failure of one chip.
- D. LED Driver:
1. Solid state driver with integral heat sink. Driver shall have overheat, short-circuit and overload protection, power factor 0.90 or above and maximum total harmonic distortion of 20 percent. Surge suppression device for all exterior luminaires.
 2. Drivers shall have dimming capabilities as outlined in the luminaire schedule for each luminaire type.
 3. Driver shall have a minimum of 50,000 hours rated life.

2.04 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
 2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
 - a. Battery: Sealed, maintenance-free, nickel-cadmium type.
 - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - f. Retain "Remote Test" Subparagraph below to allow periodic test, as required by codes for emergency equipment, to be performed using a hand-held remote device to trigger simulation of loss of normal power in the tested unit.

- g. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
- h. Retain "Integral Self-Test" Subparagraph below to eliminate necessity to manually perform periodic test required by codes for emergency equipment. Verify requirements of authorities having jurisdiction.
- i. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is announced by an integral audible alarm and a flashing red LED.

2.05 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with Section 26 0529 "Hangers and Supports" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single luminaire. Finish same as luminaire.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, **12 gage (2.68 mm)**.
- E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless-steel, **12 gage (2.68 mm)**.
- F. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.
- G. Hook Hangers: Integrated assembly matched to luminaire and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Luminaires:
 - 1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
 - 2. Install lamps in each luminaire.
- B. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.
- C. Remote Mounting of Ballasts: Distance between the ballast and luminaire shall not exceed that recommended by ballast manufacturer. Verify, with ballast manufacturers, maximum distance between ballast and luminaire.
- D. Lay-in Ceiling Luminaire Supports: Use grid as a support element.
 - 1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each luminaire. Locate not more than 6 inches (150 mm) from luminaire corners.
 - 2. Support Clips: Fasten to luminaires and to ceiling grid members at or near each luminaire corner with clips that are UL listed for the application.
 - 3. Luminaires of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support luminaires independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.
 - 4. Install at least one independent support rod or wire from structure to a tab on luminaire. Wire or rod shall have breaking strength of the weight of luminaire at a safety factor of 3.
- E. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
 2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers.
 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.
 4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.
- F. When installing luminaires, the contractor shall use the luminaire manufacturer's mounting hardware and follow all manufacturer's installation direction.
- G. All recessed downlights must be installed so that the bottom of the throat is even with the finished ceiling plane. The overlapping flange must then fit flush to the ceiling plane/throat. No light leak must be visible. All miscellaneous hardware above the ceiling plane to accomplish the above shall be included in the base bid.
- H. All recessed downlights shall have self-flanged reflectors unless otherwise noted.
- I. When luminaires are installed in continuous rows of 2 or more, luminaires shall be approved for use as wireway.

3.02 IDENTIFICATION

- A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

3.03 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- B. Illumination Observations: Verify normal operation of luminaires after installing luminaires and energizing circuits with normal power source.
- C. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.04 ADJUSTING AND CLEANING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.
- B. Align luminaires and clean lenses and diffusers at completion of work. Clean paint splatters, dirt, and debris from installed luminaires. Touch up luminaire and pole finishes as necessary.
- C. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

END OF SECTION

THISPAGELEFT INTENTIONALLY BLANK

SECTION 28 3111
DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Fire Alarm and Detection Systems.
- B. Related Sections include the following:
 - 1. Division 20 Section "Seismic Protection" for products and installation requirements necessary for compliance with seismic criteria.

1.03 DEFINITIONS

- A. LED: Light-emitting diode.
- B. NICET: National Institute for Certification in Engineering Technologies.

1.04 PERFORMANCE REQUIREMENTS

- A. The fire alarm design documents and this specification section describe the minimum required features, material quality and operational requirements of the fire alarm system. These documents do not depict every connection to be made and wire to be installed. The Vendor and Contractor are solely responsible for determining all wiring, programming, interconnections, and additional equipment required to create a complete and fully functional fire alarm system, based on the equipment and performance characteristics described within these documents.
- B. Provide all components, devices, hardware, software, programming, peripheral devices, extension components, conduit, wiring, etc., required to extend the existing fire alarm system with the new fire alarm system. Required components include, but are not limited to, initiating devices and circuits, signaling devices and circuits, notification devices and circuits, monitoring devices and circuits, power supplies, batteries, auxiliary devices, and control circuits for other building systems such as dampers, magnetic door hold open devices, etc. Extend the existing fire alarm and in a manner that the existing fire alarm system's functionality and annunciation is equivalent to the existing conditions unless otherwise noted. Upon completion of construction, the complete fire alarm system shall function as a single system, able to be reset from any single reset location point and annunciated at any annunciator location.
- C. Device layouts and limited equipment have been shown on the construction documents. Additional equipment, wiring, components, etc. required to create a complete and fully functional system has not been shown and is the responsibility of the Contractor. Shop drawing submittals shall indicate all requirements to create said fire alarm system.

1.05 SUBMITTALS

- A. General Submittal Requirements:
 - 1. Failure to comply with all the requirements within specification 26 0500 and within this specification section will result in the submitted shop drawing being rejected without review. All listed requirements must be submitted within a single submittal package.
 - 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 II minimum.
 - c. Licensed or certified by authorities having jurisdiction.

- B. Product Data: For each type of product indicated on drawings and required to complete installation if not indicated on drawings. Indicate part numbers being ordered for each equipment or component variation required. If device or equipment is shown on construction documents, indicate corresponding fire alarm symbol at the top of each product data sheet.
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Include CAD floor plans indicating the complete layout of the entire system, including auxiliary equipment, wiring and device addresses.
 - a. A legend shall be provided to indicate which fire alarm symbols correspond with construction document fire alarm symbols, if different.
 - 2. Actual routing of notification appliance circuits required for circuit survivability as dictated in Part 3 of this specification.
 - 3. Include a complete fire alarm riser diagram indicating the wiring sequence of devices and their connections to the control equipment. Include a color code schedule for the wiring.
 - 4. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
 - 5. Include voltage drop calculations for notification appliance circuits.
 - 6. Include battery-size calculations including total available capacity, used capacity and future capacity available.
 - 7. 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.
 - 8. 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.
 - 9. Provide equipment rack elevation, console layout, grounding detail and amplifier power calculations for voice alarm systems.
 - 10. Manufacturer wiring requirements, such as size, type and manufacturer.
 - 11. Photocopy of NICET certification of person overseeing the preparation of fire alarm drawings, shop drawings, installation, and testing.
 - 12. Stamp and signature of Professional Engineer overseeing fire alarm design shall be required on drawings as required to comply with local or state regulations.
- D. Installation and maintenance manuals per Section 26 0500.
- 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. 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.
 - 4. Provide shop drawings as reviewed by the Architect/Engineer and Authority Having Jurisdiction.

5. Provide hardcopy and electronically reproducible CAD floor plans indicating location of fire alarm devices, wiring and associated addresses.
- G. Software and Firmware Operational Documentation:
 1. Device address list.
- H. Project Record Documents:
 1. Submit record documents per Section 26 0500.
 2. Provide a CAD drawing of each building area depicting each device location and address. Labeling of devices on drawings shall be consistent with labeling in the field. Scale CAD drawings no smaller than 1/16 inch = 1 foot-0 inch.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
- B. Installer Qualifications: A factory authorized, licensed electrical or security contractor with minimum 5 years' experience in the design, installation, and maintenance of fire alarm systems by fire alarm system manufacturer specified and selected. Installation shall be by personnel certified by NICET as fire-alarm Level II technician.
- C. Source Limitations for Fire-Alarm System and Components: Obtain system from single source from single manufacturer. Components shall be compatible with and operate as an extension of existing system.
- D. 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.
- E. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

1.07 SYSTEM DESCRIPTION

- A. UL-certified automatic and manual addressable fire alarm system consisting of multiplexed signal transmission, dedicated to fire-alarm service only. Compliant with NFPA 72.
- B. Alarm Indication: By synchronized sounding of emergency voice alarm communication system and tone signals and synchronized flashing of strobes. Emergency voice and visual signals shall be synchronized throughout the MRI suite, with the facility system.
- C. Voice Communication: An emergency voice alarm communication system shall be utilized to notify occupants of fire alarm initiation and provide instructions to evacuate the facility using digitized voice messages. Manual voice override functionality shall be provided.

1.08 SEQUENCING AND SCHEDULING

- A. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:
 1. Notify Owner no fewer than two days in advance of proposed interruption of service.
 2. Do not proceed with interruption of service without Owner's written permission.

1.09 WARRANTY

- A. Provide one (1) year warranty for all labor and materials from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Provide products compatible with existing devices installed within facility. Devices installed in finished areas should match existing devices. Existing system is Siemens.

2.02 FIRE ALARM CONTROL PANEL

- A. General: Existing Siemens fire alarm control panel shall remain in place and be used for this project.

2.03 SIGNALING LINE CIRCUIT DEVICES

- A. Manual Fire Alarm Boxes:
1. Comply with UL 38.
 2. Boxes shall be directly connected to a SLC loop and 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.
 3. 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.
 4. Station Reset: Key- or wrench-operated switch.
- B. Smoke Detectors:
1. Comply with UL 268.
 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
 3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base in locations shown on drawings with all mounting hardware provided. 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. Photoelectric Smoke Detector: Detector shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.
 7. Detector shall be directly connected to a SLC loop. Each 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.
 8. Dual status LEDs shall be provided on each smoke detector to indicate the detector is operational and in regular communication with the control panel, or in an alarm condition.
 9. Each detector shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel.
- C. Duct Smoke Detectors:
1. Comply with UL 268A.
 2. The smoke detector housing shall accommodate an intelligent photoelectric smoke detector having the same features specified for standard smoke detectors with the following additional features required below.
 3. Provide sampling tubes and mounting hardware to match the duct to which it is attached. Sampling tube design and dimensions shall be as recommended by manufacturer for specific duct size, air velocity and installation conditions where applied. Where the detector housing is larger than the duct height, the Contractor shall fabricate a mounting bracket for the detector and attach according to the fire alarm manufacturer's recommendations.
 4. 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.

5. Weatherproof Duct Housing Enclosure for outdoor locations: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
6. Remote Indication: Provide a remote LED indicator device if detector is not visible from a floor standing position. If detector is located above a suspended ceiling, mount remote indicator in ceiling directly below detector with a white single-gang faceplate, labeled to indicate device type and mechanical equipment being monitored.

2.04 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.
- B. Audio Speaker Devices (4-inch Diameter):
 1. Match existing facility speaker size and specification.
 2. All speakers shall operate on 25V RMS system, have a minimum frequency range of 400 to 40000Hz, and shall be provided with field selectable output taps available in 3dBA increments.
 3. Speakers in corridors and public spaces shall produce a nominal sound output of 84 dBA at 10 feet.
 4. All speakers shall be capable of reproducing a clear signal consisting of a live or prerecorded voice, with intelligibility.
 5. Speakers shall be white in color.
- C. Visual Notification Appliances:
 1. Xenon strobe lights or equivalent in compliance with UL 1971 and ADAAG with clear or nominal clear lens for fire alarm systems.
 2. The maximum pulse duration shall be two-tenths of one second (0.2 second) with a maximum duty cycle of 40 percent. The flash rate shall be 1 Hertz.
 3. Visual alarm notification appliances shall be flash in a temporal pattern and fully synchronized with all other units.
 4. Rated Light Output:
 - a. 15/30/75/110 Candela, selectable in the field, as indicated on drawings.
 5. Mounting: As indicated on drawings.
 6. Strobe Leads: Factory connected to screw terminals.
- D. Combination Audible/Visual Notification Appliances:
 1. Single device with integral audible and visual notification, meeting the requirements for each component (audible and visual) per this specification.

2.05 ADDRESSABLE INTERFACE DEVICES

- A. Addressable Relays:
 1. Addressable relay module available for control of auxiliary devices, rated for the electrical load being controlled. Contractor shall provide additional slave relay(s) as required to achieve desired function.
 2. Addressable relays shall connect directly to a SLC loop and receive power from a separate 24VDC circuit. Addressable relay shall supply 24VDC power to the device(s) being controlled, unless otherwise indicated on the drawings.
- B. Addressable Monitor Modules:
 1. Addressable monitor module available for monitoring of auxiliary devices. It shall interface initiating devices with the fire alarm control panel.
 2. Addressable monitor modules shall connect directly to a SLC loop and receive power from a separate 24VDC circuit.
 3. The addressable monitor module shall provide the required power to operate the monitored device(s).

4. At the Contractor's option, an integral relay capable of providing a direct signal auxiliary device may be provided within the monitor module.

2.06 NOTIFICATION APPLIANCE CIRCUIT EXTENDER PANELS

- A. Existing Siemens notification appliance circuit extender panel shall remain in place and be used for this project.

2.07 WIRING

- A. All fire alarm wiring and cables shall be furnished and installed by the Contractor.
- B. Wiring shall be in accordance with local, state, and national codes. Number and size of conductors shall be as recommended by the fire alarm system manufacturer.
- C. All analog voice speaker and analog telephone circuits shall utilize twisted/shielded pair to eliminate cross talk.
- D. All wiring and cables shall be UL listed and labeled as complying with NFPA 70 Article 760.
 1. Class A in red conduit.

PART 3 - EXECUTION

3.01 EQUIPMENT INSTALLATION

- A. Comply with NFPA 70, NFPA 72, local and state codes and manufacturer recommendations for installation of fire-alarm equipment.
- B. Connection to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.
 1. Connecting new equipment to existing control panel in existing part of the building.
 2. Connecting new equipment to existing monitoring equipment at the supervising station.
 3. Provide all items, wiring, devices, components, programming, etc., to modify, supplement and expand the existing fire alarm system as necessary to extend existing fire alarm system. New components shall be capable of merging with existing configuration without degrading the performance of either system.
- C. Devices specified to be surface mounted shall be mounted on a manufacturer provided backbox, painted to match the color of the device. The backbox shall be the same size and shape of the device and must not have visible knockouts.
- D. Signaling Line Circuit Devices:
 1. General:
 - a. Do not install pull stations, fire alarm annunciators and signaling appliances before all dust producing construction in the area has ceased.
 - b. Ceiling mounted devices shall be located where shown on the floor plans or reflected ceiling plans. Where a conflict arises with architectural elements or other items that will not allow installation in shown location, the Contractor shall notify the Engineer to coordinate a different acceptable location.
 - c. Coordinate the location of all ceiling devices with luminaires, sprinkler heads, piping, diffusers, grilles, and other obstructions to maintain a neat and operable operation. Mounting locations and spacing must in accordance with NFPA 72.
 - d. Center ceiling mounted devices within each ceiling tile where installed in a grid type ceiling. Devices installed within hard ceilings shall be arranged in a neat and uniform pattern.
 2. Manual Fire Alarm Boxes:
 - a. Mount semi-flush in recessed back boxes, installed 48 inches above the finished floor.
 3. Smoke Detectors:
 - a. Detector heads shall not be installed until after the final construction cleaning, unless required by the Authority Having Jurisdiction. If detector heads must be installed prior

- to final cleaning, they may not be installed until they can be connected to a fully functional fire alarm control panel.
- b. All smoke detectors must be installed in accessible locations. Provide access panels as required. Coordinate with General Contractor.
 - c. Smoke detectors must be located at least 3 feet-0 inches from each supply air diffuser and return grille.
 - d. Smoke detectors shall be installed at least 12 inches from any part of a lighting fixture.
4. Duct Smoke Detectors:
- a. Duct smoke detectors with respective sampling tubes shall be installed on the duct where shown on drawings in compliance with manufacturer's requirements. Sampling tubes shall extend the full width of the duct. All duct penetrations shall be sealed airtight.
- E. Notification Appliance Devices:
1. Devices shall be located where shown on drawings.
 2. Wall mounted devices shall be installed on flush-mounted backboxes.
 3. Ceiling mounted devices shall be installed flush with ceiling, centered within ceiling tile if installed in a grid-type system. Devices installed within hard ceilings shall be arranged in a neat and uniform pattern.
 4. Where devices are to be installed in a location having a ceiling exceeding a 30 foot-0-inch height, provide stem-mounting device and support hardware, installed such that the entire device is below 30 feet-0 inches.
- F. Addressable Interface Devices:
1. Addressable Relays:
 - a. Mount each addressable relay within an enclosure located in an accessible serviceable area as near as possible to the device(s) being controlled unless otherwise specifically noted. Provide all required mounting hardware and label each enclosure to indicate relay function. Provide remote indicator to allow inspection of the device status from a floor standing location if device is not visible from a floor standing position.
 2. Addressable Monitor Modules:
 - a. Mount each addressable monitor module within an enclosure located in an accessible serviceable area as near as possible to the device(s) being controlled unless otherwise specifically noted. Provide all required mounting hardware and label each enclosure to indicate device being monitored. Provide remote indicator to allow inspection of the device status from a floor standing location if device is not visible from a floor standing position.
- G. 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.
- H. Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.02 WIRING

- A. Fire alarm wiring shall be provided by the Contractor in accordance with the manufacturer's recommendations and in compliance with the National Fire Codes.
- B. Connect all components together for a completely functional ready to operate system as shown on the drawings, as specified herein and as directed by the manufacturer.
- C. This facility will employ partial evacuation and relocation of occupants during fire alarm events. All notification appliance circuits, and network communication circuits must be installed and protected such that attack by fire within an evacuation zone does not impair control and

operation outside of the evacuation signaling zone. "Circuit survivability" requirements shall be as described in NFPA 72.

1. All circuits necessary for the operation of notification devices shall be U.L. listed type Circuit Integrity Cable installed in conduit, or electrical circuit protective system, capable of achieving a 2-hour fire rating.
 2. Outgoing and return conductors for notification appliance and network communication circuits serving separate evacuation and signaling zones shall be routed separately, such that a one (1) foot separation exists vertically, and four (4) feet of separation exists horizontally. Within ten (10) feet of the control panel, these circuits may be routed together.
- D. Fire alarm wiring splices shall be avoided.
- E. Notification appliance circuits shall not span floors.
- F. Signal line circuits connecting devices shall not span floors.
- G. All fire alarm system wiring shall be installed in a dedicated raceway. Raceway may be EMT, RMC, FMC, LFMC (flexible type limited by NEC), and surface raceway (only in areas where not subject to damage).
- H. Conduit shall be factory painted red.
- I. Ground fire alarm equipment, conductors, and cable shields per NFPA and manufacturer.

3.03 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- B. Paint all junction boxes associated with the fire alarm system red. Identify SLC and NAC circuit on junction box cover.
- C. Color Coding: Color code fire alarm conductors differently from the normal building power wiring. Differentiate the following circuit types by using different conductor colors with an overall red jacket.
1. Alarm Circuits.
 2. Supervisory Circuits.
 3. Initiating Circuits.
 4. Notification Circuits.
 5. Central Station.
 6. DC Power Supply.
 7. Power Branch Circuits.

3.04 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100 and manufacturer written requirements. Install a ground wire from main service ground to fire alarm control unit.
- B. For audio circuits, minimize the following to the greatest extent possible: ground loops, common mode returns, noise pickup, cross talk and other impairments.

3.05 SEQUENCES OF OPERATION

- A. General:
1. Refer to the Fire Alarm Operation Matrix within the drawings for basic requirements and system input/output relationships.
 2. The existing fire alarm input/output sequence of operation shall be utilized for this project.
- B. Panel/Annunciator Alarm, Trouble, Supervisory Indication:

1. Respective system Alarm, Trouble or Supervisory LED indicator light shall cycle on/off at the following locations:
 - a. Existing Fire Alarm Control Panel.
 - b. Existing Remote Annunciator Locations.
 2. Appropriate signal shall be transmitted to the central station via the digital communicator.
 3. Event date, time and type of occurrence shall be recorded within the Fire Alarm Control Panel event history.
- C. Fire Alarm Visual Alarm Sequence:
1. Visual alarms within the floor where the alarm signal was initiated along with the adjacent floors shall flash. Strobes within the building shall be synchronized.
- D. Fire Alarm Audible Alarm Sequence:
1. Audible alarms within the floor where the alarm signal was initiated along with the adjacent floors shall sound.
- E. Double Interlocked Pre-action Sprinkler Activation Sequence:
1. Utilizing an addressable relay, the fire alarm system shall signal the double interlocked pre-action sprinkler system, allowing water flow into sprinkler piping upon initiation of detection device within zone of coverage.
 2. Provide additional addressable relays for each zone required. Each zone shall be programmed to signal only the zone the alarming device is located within. Coordinate all programming and hardware requirements with the fire protection contractor.
 3. Utilizing addressable monitor modules, the control panel supervisory and trouble conditions shall be monitored by the fire alarm system.
- F. Paging System Shutdown Sequence:
1. Utilizing addressable relays or twisted pair conductor interface, the signal source shall be disconnected to shut down all sound masking/paging systems in a manner to be consistent with the facility existing sequence of operations.
- G. Smoke Damper Sequence:
1. Utilizing an addressable relay, the power connection to smoke and/or fire/smoke dampers shall be interrupted, allowing them to close. Coordinate all interconnection requirements with the mechanical contractor.
 2. In the event a smoke damper is in a main air duct and closure of this damper will completely block airflow to the ductwork system being served by that particular air handling unit, the smoke damper sequence shall also initiate the air handling unit shutdown sequence for that unit.
 3. If all the smoke and/or fire/smoke dampers associated with a particular air handling unit are closed, the air handling unit shutdown sequence shall be initiated for that unit.
 4. Smoke and/or fire/smoke dampers shall close individually or in groups, as indicated within the drawings.

3.06 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by Owner's representative and authorities having jurisdiction.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 1. Test fire alarm system in accordance with NFPA 72 Chapter 14, local Fire Marshal requirements and local building codes.
 2. 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.

3. Contractor shall test and adjust the voice fire alarm system after all furnishings, wall and floor coverings and fixed equipment is in place and operating. Measurements should be taken at a height of five feet above the finished floor level.
 - a. Adjust speaker taps to the lowest tap setting that achieves a sound level higher than or equal to the following:
 - 1) 15dBA above ambient levels as indicated in NFPA 72 table A.18.4.3
 - 2) 15dBA above measured ambient. 5dBA above the maximum measured sound level with duration of more than 60 seconds.
- D. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- E. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- F. Contractor and Owner shall coordinate actual room numbers to be used within facility. Final room numbers should be used for fire alarm system programming and record documents.

3.07 SYSTEM TRAINING

- A. Authorized manufacturer representative shall provide the following minimum on-site training to instruct the Owner's representative as required for operating the system. Hands-on demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided.
 1. System Operators: One day.
- B. The contractor and/or the system manufacturer's representatives shall provide a typewritten "Sequence of Operation."

END OF SECTION