BURNS McDONNELL

PCT Building Radiology Expansion

MU Health Care

University of Missouri Health Care

For the Curators of the University of Missouri
1 Hospital Drive
Columbia, MO 65212

MU Project No. CP221611

Construction Documents – ISSUED FOR BID/PERMIT
Specifications

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SECTION 00 00 05 - ARCHITECTURAL CERTIFICATION

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

SPECIFICATIONS SECTIONS

01 78 46.13	EXTRA STOCK AND MAINTENANCE MATERIALS - ARCHITECTURAL
02 41 19	SELECTIVE DEMOLITION
06 10 53	MISCELLANEOUS ROUGH CARPENTRY
06 40 23	INTERIOR ARCHITECTURAL WOODWORK
07 72 00	ROOF ACCESSORIES
07 84 13	PENETRATION FIRESTOPPING
07 84 43	JOINT FIRESTOPPING
07 92 19	ACOUSTICAL JOINT SEALANTS
07 95 13.13	INTERIOR EXPANSION JOINT COVER ASSEMBLIES
08 11 13	HOLLOW METAL DOORS AND FRAMES
08 14 16	FLUSH WOOD DOORS
08 31 13	ACCESS DOORS AND FRAMES
08 42 43	INTENSIVE CARE UNIT/CRITICAL CARE UNIT (ICU/CCU) ENTRANCES
08 71 11	DOOR HARDWARE
08 71 13	AUTOMATIC DOOR OPERATORS
08 80 00	GLAZING
08 88 13	FIRE-RATED GLAZING
09 21 16.23	GYPSUM BOARD SHAFT WALL ASSEMBLIES
09 22 16	NON-STRUCTURAL METAL FRAMING
09 27 13	GFRG FABRICATIONS
09 29 00	GYPSUM BOARD
09 30 00	TILING
09 51 13	ACOUSTICAL PANEL CEILINGS
09 65 00	RESILIENT FLOORING
09 65 13	RESILIENT BASE AND ACCESSORIES
09 68 00	CARPETING
09 91 24	INTERIOR PAINTING
10 21 15	CUBICLE SPECIALTIES
10 26 13	WALL AND CORNER GUARDS
10 28 13	TOILET ACCESSORIES
10 44 13	FIRE PROTECTION CABINETS
10 44 16	FIRE EXTINGUISHERS
13 49 00	RADIATION PROTECTION

Signature: *Michael Moser* Date: 2022-10-11

Michael M. Moser – MO License No.: A-2011009350

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SECTION 00 00 05 – ELECTRICAL CERTIFICATION

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

SPECIFICATIONS SECTIONS

26 05 10	BASIC ELECTRICAL REQUIREMENTS
26 05 19	LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES
26 05 26	GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
26 05 29	HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS
26 05 33	RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS
26 05 44	SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING
26 05 53	ELECTRICAL IDENTIFICATION
26 05 73	OVERCURRENT PROTECTIVE DEVICE STUDIES
26 08 00	ELECTRICAL COMMISSIONING REQUIREMENTS
26 09 23	LIGHTING CONTROL DEVICES
26 27 26	WIRING DEVICES
26 28 13	FUSES
26 28 16	ENCLOSED SWITCHES AND CIRCUIT BREAKERS
26 29 23	VARIABLE-FREQUENCY MOTOR CONTROLLERS
26 33 23	CENTRAL BATTERY EQUIPMENT FOR EMERGENCY LIGHTING
26 41 13	LIGHTNING PROTECTION FOR STRUCTURES
26 43 13	SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS
26 51 00	LED INTERIOR LIGHTING

Signature: *Eric L. Perry* Date: 2022-10-11

Eric L. Perry – MO License No.: PE-2021015034

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SECTION 00 00 05 – FIRE PROTECTION CERTIFICATION

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

SPECIFICATIONS SECTIONS

21 13 13	WET-PIPE SPRINKLER SYSTEMS
21 13 16	DRY-PIPE SPRINKLER SYSTEMS
28 31 11	DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

Signature: Cindy M. Gier Date: 2022-10-11

Cindy M. Gier – MO License No.: PE-137695

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SECTION 00 00 05 – MECHANICAL & PLUMBING CERTIFICATION

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

SPECIFICATIONS SECTIONS

22 05 18	ESCUTCHEONS FOR PLUMBING PIPING
22 05 19	METERS AND GAGES FOR PLUMBING PIPING
22 05 23	GENERAL-DUTY VALUES FOR PLUMBING PIPING
22 05 29	HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT
22 05 53	IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT
22 07 19	PLUMBING PIPING INSULATION
22 08 00	PLUMBING COMMISSIONING REQURIEMENTS
22 11 16	DOMESTIC WATER PIPING
22 11 19	DOMESTIC WATER PIPING SPECIALTIES
22 13 16	FACILITY SANITARY PIPING
22 13 19	SANITARY PIPING SPECIALTIES
22 42 13.13	COMMERCIAL WATER CLOSETS
22 42 13.16	COMMERCIAL URINALS
22 42 16.13	COMMERCIAL LAVATORIES
22 42 16.16	COMMERCIAL SINKS
22 45 00	EMERGENCY PLUMBING FIXTURES
22 62 13	VACUUM PIPING FOR LABORATORY AND HEALTHCARE FACILITIES
22 63 13	GAS PIPING FOR LABORATORY AND HEALTHCARE FACILITIES
22 64 00	MEDICAL GAS ALARMS
23 05 13	COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT
23 05 16	EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING
23 05 17	SLEEVES AND SLEEVE SEALS FOR HVAC PIPING
23 05 18	ESCUTCHEONS FOR HVAC PIPING
23 05 19	METERS AND GAGES FOR HVAC PIPING
23 05 23	GENERAL DUTY VALVES FOR HVAC
23 05 29	HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT
23 05 48	VIBRATION AND SEISMIC CONTROLS FOR HVAC
23 05 53	IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT
23 05 93	TESTING, ADJUSTING, AND BALANCING FOR HVAC
23 07 13	DUCT INSULATION
23 07 16	HVAC EQUIPMENT INSULATION
23 07 19	HVAC PIPING INSULATION
23 08 00	COMMISSIONING OF HVAC
23 09 23	DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC
23 21 13	HYDRONIC PIPING
23 21 23	HYDRONIC PUMPS
23 25 00	HVAC WATER TREATMENT
23 31 13	METAL DUCTS
23 33 00	AIR DUCT ACCESSORIES
23 34 23	HVAC POWER VENTILATORS
23 36 00	AIR TERMINAL UNITS
23 37 13	DIFFUSERS REGISTERS AND GRILLS
23 82 19	FAN COIL UNITS

Signature: Derek Hunter Date: 2022-10-11

Derek W. Hunter – MO License No.: PE-2021021523

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PROJECT MANUAL FOR: PCT Radiology Expansion

PROJECT NUMBER: CP221611 (BMcD #143839)

AT
UNIVERSITY OF MISSOURI - COLUMBIA
COLUMBIA, MISSOURI

FOR:

THE CURATORS OF THE UNIVERSITY OF MISSOURI

PREPARED BY:

Michael Moser, Project Manager
Burns & McDonnell Engineering Company, Inc.
9400 Ward Parkway
Kansas City, MO 64114
(816) 333-9400
Email: mmmoser@burnsmcd.com

DATE: October 11, 2022

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TABLE OF CONTENTS

END OF SECTION

CAMPUS FACILITIES

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

ADVERTISEMENT FOR BIDS

Sealed bids for:

PATIENT CARE TOWER –
RADIOLOGY EXPANSION
UNIVERSITY OF MISSOURI
COLUMBIA, MISSOURI
PROJECT NUMBER: CP221611 CONSTRUCTION ESTIMATE $2,694,221 - $2,993,578

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, C.T., November 10, 2022 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 Michael Moser with Burns & McDonnell Engineering Company at (816) 882-3155 or mmmoser@bunsmcd.com. Questions regarding commercial conditions should be directed to Jeff Fleenor at (573) 882-7356 or fleenorj@missouri.edu.

A prebid meeting will be held at 10:30 a.m., C.T., October 25, 2022 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: October 12, 2022

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SECTION 1.A
BID FOR LUMP SUM CONTRACT

Date:_____

BID OF _____
(hereinafter called "Bidder") a corporation* organized and existing under laws of the State of _____
_____,
a partnership* consisting of _____,
an individual* trading as _____,
a joint venture* consisting of _____
_____.
*Insert 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 Burns & McDonnell Engineering Company, Inc, entitled **"PCT Radiology Expansion** project number **CP221611**, dated September 7, 2022 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 _____
   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 for replacement of Linear Accelerator and associated chiller; 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 **Two-Hundred and Seventy (270)** 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.

c. Special scheduling requirements: Coordinate scheduling of site ready construction scope with CT, Fluoroscopy and General Radiography medical equipment vendor.

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
Electrical		
Mechanical		
Certified UL-FM Fire Stopping Contractor		

6. SUPPLIER DIVERSITY PARTICIPATION GOALS:

a. The Contractor shall have as a combined goal subcontracting with Minority Business Enterprise (MBE), Women Business Enterprise (WBE), Disadvantage Business Enterprise (DBE), and/or Veteran Owned Business of TEN PERCENT (10%); and with Service Disabled Veteran Owned Business (SDVE) of THREE PERCENT (3%) 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 Director of Facilities Planning & Development, UM, 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, WBE, DBE, and/or VETERAN PERCENTAGE PARTICIPATION: _____ percent (_____%)

SDVE 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

SECTION 1.B

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

SECTION 1.B.1

UNIVERSITY OF MISSOURI
BIDDER'S STATEMENT OF QUALIFICATIONS FOR ASBESTOS ABATEMENT

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

1. Company Name_____ Phone# _____

   Address _____

2. State of Missouri Registration number_____

3. Number of years in business _____. If not under present firm name, list previous firm names and types of organization.

   _____

   _____

4. 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

5. General character of work performed by your company personnel.

   _____

6. 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

7. Other experience qualifying you for the work now bid.

   _____

   _____

8. 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

   _____

   _____

9. (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 ____

10. 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.)

_____

_____

11. 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.)

_____

_____

12. Workers Compensation Experience Modification Rates (last 3 yrs): ____/____/____

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

13. List banking references.

_____

_____

14. (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

SECTION 1.B.2

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: _____

SECTION 1.B.3
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 _____

SECTION 1.B.4
AFFIDAVIT FOR AFFIRMATIVE ACTION

State of Missouri)
) ss.
County of)

_____ 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_____.

SECTION 1.B.5
CERTIFYING SUPPLIER DIVERSITYAGENCIES

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/sldc/

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
W: oeo.mo.gov/

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SECTION 1.B.6
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.scannews.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

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SECTION 1.B.7

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.

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Contractor: _____	Diverse Firm: _____
Signature: _____	Signature: _____
Name: _____	Name: _____
Title: _____	Title: _____
Date: _____	Date:_____

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SECTION 1.C

University of Missouri

INFORMATION FOR BIDDERS

Page No.

1. Contract Documents

1.1 Drawings, specifications, and other contract documents, pursuant to work, which is to be done, may be obtained shown in the Advertisement for Bids and Special Conditions.

2. Bidder Obligations

2.1 Before submitting bids, each bidder shall carefully examine the drawings and specifications and related contract documents, visit site of work, and fully inform themselves as to all existing conditions, facilities, restrictions, and other matters which can 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 hereinafter specified.

2.3 Failure or omission of any bidder to receive or examine any form, instrument, addendum, or other document, or to visit the site and acquaint themselves with existing conditions, shall in no way relieve them from any obligation with respect to their bid or contract, and no extra compensation will be allowed by reason of anything or matter concerning which bidder should have fully informed themselves prior to bidding.

2.4 Submission of bids shall be deemed acceptance of the above obligations and each and every obligation required to be performed by all of the contract documents in the event the bid is accepted.

3. Interpretation of Documents

3.1 If any prospective bidder is in doubt as to the true meaning of any part of the drawings and specifications or contract documents, they shall submit a written request to the Architect for an interpretation.

3.2 Requests for such interpretations shall be delivered to the Architect at least one (1) week prior to time for receipt of bids.

3.3 Bids shall be based only on interpretations issued in the form of addenda mailed to each person who is on the Architect's record as having received a set of the contract documents.

4. Bids

4.1 Bids shall be received separately or in combination as shown in and required by the Bid for Lump Sum contract. Bids will be completed so as to include insertion of amounts for alternate bids, unit prices and cost accounting data.

4.2 Bidders shall apportion each base bid between various phases of the work, as stipulated in the Bid for Lump Sum contract. All work shall be done as defined in the specifications and as indicated on the drawings.

4.3 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. Bidders shall be responsible for actual delivery of bids 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.

4.4 The bidder's price shall include all federal sales, excise, and similar taxes, which may be lawfully assessed in connection with their performance of work and purchase of materials to be incorporated in the work. City & State taxes shall not be included as defined within Article 3.16 of the General Conditions for Construction Contract included in the contract documents.

4.5 Bids shall be submitted on a single bid form, furnished by the Owner or Architect. Do not remove the bid form from the specifications.

4.6 No bidder shall stipulate in their bid any conditions not contained in the bid form.

4.7 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 The bidder may withdraw their bid at any time before the scheduled closing time for receipt of bids, but no bidder may withdraw their bid after the scheduled closing time for receipt of bids.

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

6. Signing of Bids

6.1 Bids which are signed for a partnership shall be **manually** signed in the firm name by at least one partner, or in the firm name by 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 dated the same date as the bid and executed by all partners of the firm.

6.2 Bids that are signed for a corporation shall have the correct corporate name thereon and the signature of an authorized officer of the corporation manually written below corporate name. Title of office held by the person signing for the corporation shall appear below the signature of the officer.

6.3 Bids that are signed by an individual doing business under a firm name, shall be manually signed in the name of the individual doing business under the proper firm name and style.

6.4 Bids that are signed under joint venture shall be manually signed by officers of the firms having authority to sign for their firm.

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 bidder's bid including additive alternates.

7.2 Bid security is required as a guarantee that bidder will enter into a written contract and furnish a performance bond within the time and in form as specified in these specifications; 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 48 hours (2 workdays) of the bid opening of any circumstance that may affect the bid security including, but not limited to, a bidding error. 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 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-/XI.

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 their contract and performance bond, nor limit or fix bidder's liability to Owner for any damages sustained because of failure to execute and deliver the required contract and performance bond.

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

8. Bidder's Statement of Qualifications

8.1 Each bidder submitting a bid 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 schedule of information set forth in the form furnished in the bid form.

8.2 Such information, a single copy required in a separate sealed envelope, will be treated as confidential information by the Owner, within the meaning of Missouri Statue 610.010.

8.3 Bids not accompanied with current 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 by way of limitation, 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 bidder's, and their subcontractor's, ability to handle promptly the additional work, skill, facilities, capacity, experience, ability, responsibility, previous work, financial standing of bidder, and the bidder's ability to provide the required bonds and insurance; quality, efficiency and construction of equipment proposed to be furnished; period of time within which equipment is proposed to be furnished and delivered; success in achieving the specified Supplier Diversity goal, or demonstrating a good faith effort as described in Article 15; necessity of prompt and efficient completion of work herein described, 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 Contractor shall submit within fifteen (15) days from receipt of notice, the documents required in Article 9 of the General Conditions for Construction Contract included in the contract documents.

10.2 No bids will be considered binding upon the Owner until the documents listed above have been furnished. Failure of Contractor to execute and submit these documents within the time period specified will be treated, at the option of the

Owner, as a breach of the bidder's bid security under Article 7 and the Owner shall be under no further obligation to 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 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 Contractor's faithful performance of this Contract, including but not limited to 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.

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

11.3 If the surety of any bond furnished by 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, Contractor shall within ten (10) days substitute another bond and surety, both of which must be acceptable to Owner. If Contractor fails to make such substitution, Owner may procure such required bonds on behalf of Contractor at Contractor's expense.

12. Time of Completion

12.1 Contractors 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 for Construction Contract included in the contract documents.

13. Number of Contract Documents

13.1 The Owner will furnish the Contractor a copy of the executed contract and performance 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, andmanufactured in marketable quantity and quality in the Stateof 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

The Supplier Diversity participation goal for this project is stated on the Bid for Lump Sum Contract Form, and the Owner will take into consideration the bidder's success in achieving the Supplier Diversity participation goal in awarding the contract. Inability of any bidder to meet this requirement may be cause for rejection of their bid.

A 3-point Service-Disabled Veteran Enterprises (SDVE) bonus preference shall apply to this contract. The 3 bonus points can be obtained by a certified, Missouri based SDVE performing a commercially useful function, (as defined in Article 1 of the General Conditions of the Contract for Construction) either by submitting a bid directly to the Owner, or through the utilization of certified SDVE subcontractors and/or suppliers, whose participation provides atleast 3% of the total bid amount. A firm does not perform a commercially useful function if its role is limited to that of an extra participant in a transaction, contract, or project through which funds are passed in order to obtain the appearance of SDVE participation. In determining whether a firm is such an extra participant, the Owner will examine similar transactions, particularly those in which SDVEs do not participate. The 3-point bonus preference shall be calculated and applied by reducing the bid amount of the eligible bidder by three (3) percent of the apparent low responsive bidder's bid. Based on this calculation, if the eligible bidder's resulting total bid valuation is less than the apparent low responsive bidder's bid, the eligible 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 eligible bidder's bid or the amount(s) of any contract awarded. The submitted bid form must include a minimum of 3% SDVE participation to obtain the three (3) point bonus. For every SDVE firm utilized, a completed AFFIDAVIT OF SUPPLIER DIVERSITY PARTICIPATION form shall be submitted to the Owner within 24 hours of the receipt of bids. Failure to do so may be grounds for rejection of the SDVE bonus preference.

15.2 List of Supplier Diversity Firms

15.2.1 The bidder shall submit as part of their bid a list of diverse firms performing as contractor, subcontractors, and/or suppliers. The list shall specify the single designated diverse firm name and address. If acceptance or non-acceptance of alternates will affect the designation of a subcontractor, provide information for each affected category.

15.2.2 Failure to include a complete list of diverse firms 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 for Lump Sum Contract Form.

15.3 Supplier Diversity Percentage Goal

The bidder shall have a minimum goal of subcontracting with diverse contractors, subcontractors, and suppliers, the percent

of contract price stated in the Supplier Diversity goal paragraph of the Bid for Lump Sum Contract Form.

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15.4 Supplier Diversity Percent Goal Computation

15.4.1 The total dollar value of the work granted to the diverse firms by the successful bidder is counted towards the applicable goal of the entire contract, unless otherwise noted below.

15.4.2 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 and carrying out its responsibilities by actually performing, managing and supervising the work involved. A bidder that is a certified diverse firm may count as 100% of the contract towards the Supplier Diversity goal. For projects with separate MBE, SDVE, and WBE/Veteran/DBE goals, a MBE firm bidding as the prime bidder is expected to obtain the required SDVE, and WBE/Veteran/ DBE participation; a WBE or Veteran or DBE firm bidding as the prime bidder is expected to obtain the required MBE and SDVE participation and a SDVE firm bidding as the prime bidder is expected to obtain the required MBE, and WBE/Veteran/ DBE participation.

15.4.3 When a MBE, WBE, Veteran Business Enterprise, DBE, or SDVE performs work as a participant in a joint venture, only the portion of the total dollar value of the contract equal to the distinct, clearly defined portion of the work of the contract that the MBE, WBE, Veteran Business Enterprise, DBE, or SDVE performs with its own forces shall count toward the MBE, WBE, Veteran Business Enterprise, DBE, or SDVE individual contract percentages.

15.4.4 The bidder may count toward its Supplier Diversity goal expenditures for materials and supplies obtained from diverse suppliers and manufacturers, provided the diverse firm assumes the actual and contractual responsibility for the provision of the materials and supplies.

15.4.4.1 The bidder may count its entire expenditure to a diverse manufacturer. A manufacturer shall be defined as an individual or firm that produces goods from raw materials or substantially alters them before resale.

15.4.4.2 The bidder may count its entire expenditure to diverse suppliers that are not manufacturers provided the diverse supplier performs a commercially useful function as defined above in the supply process.

15.4.4.3 The bidder may count 25% of its entire expenditures to diverse firms that do not meet the definition of a subcontractor, a manufacturer, nor a supplier. Such diverse firms may arrange for, expedite, or procure portions of the work but are not actively engaged in the business of performing, manufacturing, or supplying that work.

15.4.5 The bidder may count toward the Supplier Diversity goal that portion of the total dollar value of the work awarded to a certified joint venture equal to the percentage of the ownership and control of the diverse partner in the joint venture.

15.5 Certification by Bidder of Diverse Firms

15.5.1. The bidder shall submit with its bid the information requested in the "Supplier Diversity Compliance Evaluation Form" for every diverse firm the bidder intends to award work to on the contract.

15.5.2. Diverse firms are defined in Article 1 – (Supplier Diversity Definitions) of the General Conditions of the Contract for Construction included in the contract documents, and as those businesses certified as disadvantaged by an approved agency. The bidder is responsible for obtaining information regarding the certification status of a firm. A listof certified firms may be obtained by contacting the agencies listed in the proposal form document "Supplier Diversity Certifying Agencies." Any firm listed as disadvantaged by any of the identified agencies will be classified as a diverse firm by the Owner.

15.5.3. Bidders are urged to encourage their prospective diverse contractors, subcontractors, joint venture participants, team partners, and suppliers who are not currently certified to obtain certification from one of the approved agencies.

15.6 Supplier Diversity Participation Waiver

15.6.1 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 diverse firms and has failed, the bidder shall submit with the bid, 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 applicable percentage goal. 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 include Supplier Diversity participation may be awarded the contract regardless of the percent of Supplier Diversity participation, provided the bid is otherwise acceptable and is determined to be the best bid.

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

15.6.2.1 The bidder's attendance at pre-proposal meetings scheduled to inform bidders and diverse firms of contracting and subcontracting opportunities and responsibilities associated with Supplier Diversity participation.

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

15.6.2.3 The bidder's written notice to specific diverse firms that their services were being solicited in sufficient time to allow for their effective participation.

15.6.2.4 The bidder's follow-up attempts to the initial solicitation(s) to determine with certainty whether diverse firms were interested.

15.6.2.5 The bidder's efforts to divide the work into packages suitable for subcontracting to diverse firms.

15.6.2.6 The bidder's efforts to provide interested diverse firms with sufficiently detailed information about the drawings, specific actions and requirements of the contract, and clear scopes of work for the firms to bid on.

15.6.2.7 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 firms contacted a description of all information provided the diverse firms, and an explanation as to why agreements were not reached.

15.6.2.8 The bidder's efforts to locate diverse firms not on the directory list and assist diverse firms in becoming certified as such.

15.6.2.9 The bidder's initiatives to encourage and develop participation by diverse firms.

15.6.2.10 The bidder's efforts to help diverse firms overcome legal or other barriers impeding the participation of diverse firms in the construction contract.

15.6.2.11 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.

15.7 Submittal of Forms

15.7.1 The bidder will include the Supplier Diversity Compliance Evaluation Form(s), or the Application for Waiver and other form(s) as required above in the envelope containing the "Bidder's Statement of Qualifications", see Article 8.

15.8 Additional Bid/Proposer Information

15.8.1 The Contracting Officer reserves the right to request additional information regarding Supplier Diversity participation and supporting documentation from the apparent low bidder. The bidder shall respond in writing to the Contracting Officer within 24 hours (1 workday) of a request.

15.8.2 The Contracting Officer reserves the right to request additional information after the bidder has responded to prior 24-hour requests. This information may include follow up and/or clarification of the information previously submitted.

15.8.3 The Owner reserves the right to consider additional diverse subcontractor and supplier participation submitted by the bidder after bids are opened under the provisions within these contract documents that describe the Owner's right to accept or reject subcontractors including, but not limited to, Article 16 below. The Owner may elect to waive the good faith effort requirement if such additional participation achieves the Supplier Diversity goal.

15.8.4 The Bidder shall provide the Owner information related to the Supplier Diversity participation included in the bidder's proposal, including, but is not limited to, the complete Application for Waiver, evidence of diverse certification of participating firms, dollar amount of participation of diverse firms, information supporting a good faith effort as described in Article 15.6 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 bid by the diverse firm.

16. List of Subcontractors

16.1 If a list of subcontractors is required on the Bid for Lump Sum Contract Form, the bidders shall list the name, city and state of the firm(s) which 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 Article 15.2, and the complete list of subcontractors required in Article 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 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 bidding errors, listed subcontractor's inability to perform the work for the bid used, etc. Any request to change a listed subcontractor shall include at a minimum, contractor's 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 of this document and Article 5 of the General Conditions of the Contract for Construction included in the contract documents will apply.

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SECTION 1.D

University of Missouri

General Conditions

of the

Contract

for

Construction

December 2021 Edition

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TABLE OF ARTICLES

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 Curators of the University of Missouri. The Owner may act through its Board of Curators or any duly authorized committee or representative thereof.

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 work performed is 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 Supplier Diversity Definitions
Businesses that fall into the Supplier Diversity classification shall mean an approved certified business concern which is at least fifty-one percent (51%) owned and controlled by one (1) or more diverse suppliers 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 and 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 DBE's 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 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 Architect in connection with Substantial Completion of the Work or a portion of the Work, which the Owner’s Representative or Architect has designated as remaining to be performed, completed, or corrected before the Work will be accepted by the Owner.

1.1.20 Public Works Contracting Minimum Wage
The public works contracting minimum wage shall be equal to one hundred twenty percent of the average hourly wage in a particular locality, as determined by the Missouri economic research and information center within the department of economic development, or any successor agency.

1.1.21 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 by 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 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 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 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. 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. Owner's lifting of Stop Work Order shall not prejudice 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, 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 Owner.

2.4 Extent of Owner Rights

2.4.1 The rights stated in this 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 breech 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 the work 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 breech 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 (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, as stated in 2.1.1 above.

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 or corporation or joint venture 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 3.17.2 of 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. 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 Contractor to comply with the provisions of this Paragraph shall cause Contractor to forfeit any right to an adjustment of the Contract Sum or Contract Time for any postponement, rescheduling or other delays ordered by 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 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 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 its 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 his 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 him.

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 entity or other 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 Architect in their administration of the Contract, or by tests, inspections or approvals required or performed by persons other than the Contractor.

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

3.5 Use of Site

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

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

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

3.5.4 The Contractor shall ensure that the Work is at all times performed in a manner that affords reasonable access, both vehicular and pedestrian, to the site of the Work and all adjacent areas. Particular attention shall be paid to access for emergency vehicles, including fire trucks. Wherever there is the possibility of interfering with normal emergency vehicle operations, 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, 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. 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 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 Owner and shall at once report in writing to the Architect and 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 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 Owner's Representative within twenty-four (24) hours. During the progress of work, Contractor shall verify all field measurements prior to fabrication of building components or equipment and proceed with the fabrication to meet field conditions. 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 Owner's Representative and Architect. 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 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 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, Contractor acknowledges that cutting and patching of the Work is essential for the Work to be successfully completed. 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, 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 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, 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 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 Contractor refuses to assume or perform, or delays in assuming or performing 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 Contractor whether or not an Indemnitee has made such demand. Even if a defense is successful to a claim or demand for which Contractor is obligated to indemnify the Indemnitees from under this Paragraph, Contractor shall remain liable for all costs of defense.

3.9.2 The indemnity obligations of 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. Owner reserves the right to control the defense and settlement of any claim, action or proceeding which Contractor has an obligation to indemnify the Indemnitees against under Paragraph 3.9.1.

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, his 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, he 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 his 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 3.12.1.

3.12.8.2 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 Owner's Representative in sufficient time to allow the Architect and 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 Architect and 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 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 Contractor from its obligation to ensure that an "or equal" article, appliance, devise, or material strictly complies with the requirements of the Contract Documents. Contractor shall not propose "or equal" items in connection with Shop Drawings or other Submittals, and 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 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 90 days of the Notice to Proceed. If Contractor believes that this milestone is unreasonable for any submittal, Contractor shall request an extension of this milestone, within 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 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 Contractor and the name and number of the Owner's project. Quantities of Samples shall be twice the number required for testing so that Architect can return one set of the Samples. Materials delivered before receipt of Architect's approval may be rejected by Architect and in such event, Contractor shall immediately remove all such materials from the Work site. When requested by Architect or 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. Contractor shall also coordinate each Submittal with other Submittals.

3.14.10 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 Contractor has satisfied its obligations under the Contract Documents with respect to Contractor's review and approval of that Submittal. Each Submittal shall bear the signature of the representative of 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, Contractor acknowledges that Architect's approval of Shop Drawings shall not relieve Contractor for responsibility for errors and omissions in the Shop Drawings since 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 Owner or Architect may reasonably request. The prints for Record Drawing use will be a set of "blue line" prints provided by Architect to Contractor at the start of construction. Upon Substantial Completion of the Work, Contractor shall deliver all Record Drawings to Owner and Architect for approval. If not approved, Contractor shall make the revisions requested by Architect or Owner's Representative. Final payment and any retainage shall not be due and owing to Contractor until the final Record Drawings marked by Contractor as required above are delivered to 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.

(a) Recommended spare parts including catalog number and name of local suppliers or factory representative.

(b) Belt sizes, types, and lengths.

(c) 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 RSMo § 144.062. The Contractor shall be issued a Project Tax Exemption Certificate for this Work to obtain the benefits of RSMo § 144.062.

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, Owner shall be liable for the tax owed.

3.17.5 The Owner shall not be responsible for any tax liability due to Contractor's neglect to make timely orders, payments, etc. or Contractor's misuse of the Project Tax Exemption Certificate. Contractor represents that the Project Tax Exemption Certificate shall be used in accordance with RSMo § 144.062 and the terms of the Project Tax Exemption

Certificate. Contractor shall indemnify the Owner for any loss or expense, including but not limited to, reasonable attorneys' fees, arising out of 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 Architect's information 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 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, 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, 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 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 3.17.3. The Owner may exercise the rights furnished the Owner under or pursuant to this Paragraph 3.17.3 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. Contractor shall be obligated to promptly proceed with this work. If Contractor feels that it is entitled to additional compensation for this work, it may file a claim for additional compensation and/or time, in accordance with 4.4 of this Document.

4.1.4 The Owner's Representative, may, by written notice, require a Contractor to remove from involvement with the Work, any of 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. 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 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 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 recision. Claims must be made by written notice. Contractor shall have the responsibility to substantiate Claims.

4.4.2 Claims by 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 Contractor. The notice of Claims shall also strictly comply with all other provisions of the Contract Documents. 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. Contractor shall furnish the Owner and 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 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, 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 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, 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 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 contract 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 contract 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 completion 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 this 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 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's 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 Director of Facilities Planning and Development, University of Missouri, 109 Old Alumni Centers, 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. Contractor and 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. Contractor agrees not to file any complaint, petition, lawsuit or legal proceeding against 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, 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 his work at the proper time. Each Contractor shall be required to coordinate his 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 Owner's or other Contractor's property done by him or persons in his employ, 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 his 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 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, 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 orders 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 change order 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 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). 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, Contractor shall promptly proceed with the change in the Work involved and advise Owner of 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, expediters, 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 his 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. 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 Article 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 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 Contractors 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, 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 Contractor acknowledges and agrees that time is of the essence of this Contract

8.1.2 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, Contractor shall be liable for such liquidated damages as set forth in Paragraph 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 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 Contractor provide 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 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 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 Contractor or by acts or omissions of Contractor or its Subcontractors of any tier or delays beyond the control of both Owner and 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, Contractor shall provide written notice to the Owner within seven (7) calendar days of the event giving rise to such claim. 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, Contractor shall only be entitled to its actual direct costs caused thereby and 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 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 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 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 his 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. 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 13.4)

9.1.4 In the event Contractor fails to provide Owner such documents, 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 Contractor access to the site as a result of Contractor's failure to provide such documents and Contractor shall not be entitled to an adjustment of the Contract Time or Contract sum as a result of its failure to comply with the provisions of this Paragraph

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 Contractor represent and warrant that the person signing the Contract has the legal authority to bind 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 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. 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). 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 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 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 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. 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 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 Article, Offsite is defined as any location not owned or leased by the Owner. Contractor shall submit a list of materials that they are requesting payment for offsite storage within 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 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 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. 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 and Bailment Agreement 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 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, 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 Contractor;

.8 Contractor's failure to comply with applicable Laws;

.9 Contractor's or Subcontractor's failure to comply with contract Prevailing Wage requirements; or

.10 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 Contractor for amounts due and approved by 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 Contractor, Applications for Payment submitted by Contractor

shall indicate the actual percentage of completion of each portion of 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 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 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 Owner, and no other person, firm or corporation shall have any claim or right whatsoever thereto.

9.7.7 An approval for payment by 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 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 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 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 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 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, Owner's

Representative will return Contractor's Final Application for Payment to 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's 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 Contractor of its Final Payment, by check or electronic transfer, shall be and operate as a release of all claims of Contractor against Owner for all things done or furnished or relating to the Work and for every act or alleged neglect of 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 Owner's receipt of Contractor's Final Application for Payment which satisfies all the requirements of the Contract Documents and 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 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 All contractors, subcontractors and workers on this project are subject to the Construction Safety Training provisions 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 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 referred to in Article 10 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 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 Architect. The Contractor shall hold regularly scheduled safety meetings to instruct Contractor 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 & BONDS

11.1 Insurance

11.1.1 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 Contractor, 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 Owner, but, regardless of such approval, it shall be the responsibility of Contractor to maintain the insurance coverages set forth herein.

11.1.2 The contractor shall not be allowed on the Owners property without proof of the insurance coverages set forth herein

11.2 Commercial General Liability

11.2.1 Contractor shall secure and maintain from the date of the Contract and for a period of at least five (5) 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 should apply per project. An umbrella policy may be used to satisfy these limits. If the General Aggregate is not on a per project basis, the contractor shall provide an additional $2,000,000 general aggregate.

11.2.2 CGL insurance shall be written on a comprehensive form 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.

11.2.5 "The officers, employees, and agents of The Curators of the University of Missouri" shall be endorsed as an "additional insured" under the CGL policy. The additional insured status must be conveyed by using the ISO CG 2 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.

11.2.6 Contractor waives all rights against 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 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 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 Contractor waives all rights against 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 Contractor shall purchase and maintain workers' compensation insurance and employers' liability insurance which shall protect Contractor from claims for injury, sickness, disease or death of 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 sublet, Contractor shall require any Subcontractor of any tier to provide the insurance coverages required under this Section 11.4.

11.4.2 Contractor's workers' compensation insurance coverage shall be in compliance with all applicable Laws, including the statutes of the State of Missouri. 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 Liability Insurance General/Other Requirements

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 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 occurrence/$1,000,000.00 aggregate. The insurance afforded by the policy shall meet the requirements of this Section 11.2 and Section 11.5 relating to CGL Policies, and without limiting the foregoing, shall be extended to cover the liability of "The officers, employees, and agents of The Curators of the University of Missouri", who shall be named as additional insureds therein, and this liability is assumed in writing by the Contractor's Consultant under the written Subcontract described herein. All insurance coverages procured by Contractor shall be provided by agencies and insurance companies acceptable to and approved by Owner. Any insurance coverage shall be provided by insurance companies that are duly licensed to conduct business in the State of Missouri as an admitted carrier. The form and content of all insurance coverage provided by Contractor are subject to the approval of Owner. All required insurance coverages shall be obtained and paid for by Contractor. Any approval of the form, content or insurance company by Owner shall not relieve the Contractor from the obligation to provide the coverages required herein.

11.5.2 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 Contractor covering the additional insureds shall be primary insurance and any insurance maintained by Owner shall be excess insurance.

11.5.3 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. Contractor shall cause its insurance carriers to waive all rights of subrogation,

except for Workers' Compensation, against the Owner and its officers, employees and agents.

11.5.4 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. Contractor is required to maintain coverages as stated and required to notify the University of a Carrier Change or cancellation within 2 business days. The University reserves the right to request a copy of the policy. 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.

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

11.5.6 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 Contractor's exercise or enforcement of any rights under the Contract Documents.

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

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

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

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

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

11.5.12 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 hereunder; 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.

11.5.13 It is understood and agreed that the insurance coverages required by the provisions of this Article 11 are required in the public interest and that the Owner does not assume any liability for acts of 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, 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 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, including ocean transit. The policy shall include as insured property scaffolding, falsework, and temporary buildings located at the site. The policy shall cover the cost of removing debris, including demolition as may be made legally necessary by the operation of any law, ordinance, or regulation.

11.6.4 The insurance required herein shall be on an all risk form and shall be written to cover all risks of physical loss or damage to the insured party and shall insure at least against the perils of fire and extended coverage, theft, vandalism,

malicious mischief, collapse, lightening, earthquake, flood, frost, water damage, windstorm and freezing.

11.6.5 If there are any deductibles applicable to the insurance required herein, 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 Owner to 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 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 obtained pursuant to this Section 11.7 or other insurance applicable to the Work, except such rights as they have to proceeds of such insurance. The Owner or 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 Contractor's property insurance shall be adjusted by the Owner in good faith and made payable to the Owner for the insureds, subject to requirements of the Contract Documents. The Contractor shall pay Subcontractors of any tier their just shares of insurance proceeds received by the Contractor, and by appropriate agreements, written where legally required for validity, shall require Subcontractors of any tier to make payments to their Sub-subcontractors in similar manner.

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 Contractor's faithful performance of this Contract, including but not limited to 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 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 paragraph, Contractor shall within ten (10) days substitute another bond and surety, both of which must be acceptable to Owner. If Contractor fails to make such substitution, Owner may procure such required bonds on behalf of Contractor at 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 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 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 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 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 Architect or Owner's Representative, the Architect or 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." 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 12.2.2 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 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 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, 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, 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, Owner's Representative and/or the Owner's Authorized Agent , ~~so~~ 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 Architect.

13.3.5 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 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 Architect or Owner with a reasonable belief that additional defective Work may be found, in which case Contractor shall be responsible for all costs of tests and inspections ordered by the Owner or 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 the United States government. Accordingly, the provider of goods and/or services shall comply with

federal laws, rules and regulations applicable to subcontractors of government contracts including those relating to equal employment opportunity and affirmative action in the employment of 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]) contracting with business concerns with small disadvantaged business concerns (Publication L. 95-507). Contract clauses required by the Government in such circumstances are incorporated herein by reference.

13.5 Supplier Diversity Goal Program

13.5.1 The Contractor shall subcontract with diverse firms no less than the amount pledged in the Contractor's Bid and/or the amount accepted by the Owner.

13.5.2 If the Contractor must remove any diverse subcontractor of any tier, the Contractor shall replace the diverse subcontractor of any tier with another diverse subcontractor(s) of equal dollar value to the diverse supplier removed. The Contractor shall immediately notify the Owner's Representative in writing of the Contractor's intent to remove any, and the Contractor's plan to maintain subcontracts with diverse firms of no less than amount pledged in the Contractor's Bid and/or the amount accepted by the Owner. All changes of diverse subcontractor of any tier shall be approved by the Director of Facilities Planning & Development.

13.5.3 If the Contractor fails to meet or maintain the contractor's Supplier Diversity subcontracting pledge, the Contractor shall immediately notify in writing the Owner's Representative, and the Director of Facilities Planning & Development. Such notice shall include a description of the Contractor's good faith effort to comply with their Supplier Diversity subcontracting pledge.

13.5.4 If the Director of Facilities Planning & Development finds the Contractor has failed to comply in good faith with the Owner's Supplier Diversity goal program, the 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 Director of Facilities Planning & 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 affirmative 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 this non-discrimination requirement, 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 Supplier 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 contract adjustments that increase the contract above $75,000 will be subject to this section.)

13.6.1 The Contractor shall pay workers employed in the execution of this contract in full each week and not less than the predetermined wage rates and overtime for work of a similar character that have been made a part of this Contract. These rates are determined by the University of Missouri Director of Facilities Planning and Development. The rates are based on wage rates published in the Annual Wage Orders of the Missouri Department of Labor and Industrial Relations (MDLIR). The Contractor is to use MDLIR 8 CSR 30-3.020; .030; .040, .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 Director of Facilities Planning and Development. The Contractor is responsible for the payment of the aggregate of the Basic Hourly Rate and the Total Fringe Benefits to the workers on the project. 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 §290.210(5) RSMo 1994. 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. In the event the contract contains more than one wage determination the Contractor shall comply with both.

13.6.2 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 10 days of the Owner's written request. The Contractor shall provide copies of workers I-9 forms within 24 hours of written notice. (If applicable, and required by Owner, the Contractor will demonstrate that the Contractor is enrolled and participating in a federal work authorization program with respect to the employees working in connection with this project.) 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. The contractor further agrees, in the event the records are not presented as requested, he will abide by any decision made by the Owner regarding underpayment of wages to workers and amounts owed them as well as liquidated damages for underpayment of wages. Falsification of the certified payroll records may result in the debarment of the contractor or subcontractor from future work with the University.

13.6.3 The acquisition of products or services is subject to the supplier's conformance to the rules and regulations of the President's Committee on Equal Employment Opportunity (41 CFR, Ch. 60).

13.6.4 The Contractor shall comply with the Copeland Regulations of the Secretary of Labor (29 CFR, Part 3), which are incorporated herein by reference. In addition, the Weekly Statement of Compliance required by these Regulations shall also contain a statement that the applicable fringe benefits paid are equal to or greater than those set forth in the minimum wage decision.

13.6.5 Contractor acknowledges that violation of the requirements of Article 13.6 result in additional costs to Owner, including, but not limited to, cost of construction delays, of additional work for Owner's staff and legal expense. The cost of Contractor's violation of the provisions of Article 13.6 would be and is difficult to determine and establish. In the event that Contractor fails to comply with the provisions of this Article 13.6, Owner shall be entitled to retain or recover from the Contractor, as liquidated damages and not as a penalty, the sum of Fifty Dollars ($50.00) per day per individual who is paid less than the applicable prevailing wage, to approximate the investigative cost resulting to the Owner for such violations. To approximate the delay costs, Owner shall be entitled to retain or recover from the Contractor, as liquidated damages and not as a penalty, the sum of One Hundred Dollars ($100.00) per day for each day the Contract cannot be closed out and final payment made because of Contractor's failure to comply with the provisions of this Article 13.6. Such liquidated damages shall be collected regardless of whether the Work has been completed. The liquidated damages and other amounts set forth in this Article 13.6 shall be in addition to all other liquidated damages the Owner may be entitled as set forth in the Contract Documents.

13.6.6 The Owner may deduct liquidated damages described Article 13 and the amounts set forth in Article 13 from any unpaid amounts then or thereafter due the Contractor under the Contract. Any liquidated damages not so deducted from any unpaid amounts due the Contractor shall be payable to the Owner at the demand of the Owner.

13.6.7 The Contractor shall specifically incorporate the obligations of Article 13 into the subcontracts, supply agreements and purchase orders for the Work and require the same of any Subcontractors of any tier.

13.6.8 Contractor acknowledges and recognizes that a material factor in its selection by the Owner is the Contractor's willingness to undertake and comply with the requirements of this Article 13.6. If Contractor fails to comply with the provisions of this Article 13.6, Owner may, in its sole discretion, immediately terminate the Contract

upon written notice. The rights and remedies of Owner provided herein shall not be exclusive and are in addition to other rights and remedies provided by law or under this Contract.

13.6.9 Only such workers who are individually registered in a bona fide apprenticeship program approved by the U.S. Department of Labor, Office of Apprenticeship can be paid less than the journeyperson rate of pay. "Entry Level Workers; must be registered apprentices. The apprenticeship ratio will be one to one with a journeyperson of the same classification. Any worker not registered as an apprentice per this section will be paid as a journeyperson.

13.6.10 The Contractor shall post the wage rates for the contract in a conspicuous place at the field office on the project. On projects where there is no field office the Contractor may post the wage rates at their local office, as long as they provide a copy of the wage rates to a worker upon request. The wage rates shall be kept in a clearly legible condition for the duration of the project.

13.6.11 Neither the Contractor, nor any Subcontractor of any tier, nor any person hired by them or acting on their behalf, shall request or demand that workers pay back, return, donate, contribute, or give any part, or all, of said workers wages, salary, or any thing of value, upon the statement, representation or understanding that failure to comply with such request or demand will prevent such worker from procuring or retaining employment. 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.

13.6.12 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 prevailing wage rate as provided in 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. Any employer not in compliance with this Article shall owe to the University double the dollar amount per hour that the wage subsidy, bid supplement, or rebate has reduced the wage rate paid by the employer below the prevailing wage rate for each hour that work was performed.

13.6.13 Time and one-half overtime will be paid on all hours over 10 hours per day or 40 hours per week. The wage rate is the total of the "Basic Hourly Rate" plus "Total Fringe Benefits" or the "public works contracting minimum wage". 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. 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.

13.7 Records

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.

13.8 Codes 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. Contractor and 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 Contractor and 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 Contractor and Owner. Contractor agrees that it shall not file any petition, complaint, lawsuit or legal proceeding against Owner in any other court other than the State of Missouri Circuit Court for the County where the Project is located.

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

13.9.5 Contractor agrees that Owner shall not be liable to Contractor for any special, indirect, incidental, or consequential damage whatsoever, whether caused by 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. 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 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. Contractor shall not assign the Contract or proceeds hereof without written consent of the Owner. If Contractor attempts to make such an assignment without such consent, it shall be void and confer no rights on third parties, and Contractor shall nevertheless remain legally responsible for all obligations under the Contract. The Owner's consent to any assignment is conditioned upon 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 Certification

13.10.1 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 Federal department or agency in accordance with Executive Order 12549 (2/18/86).

13.10.2 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.

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 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, Architect, or 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 Contractor and 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 Paragraph 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 Architects services and expenses made necessary thereby, such excess will be paid to the Contractor; but, if such expenses of 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 Article 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 this Article 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 Paragraph 14.1 was wrongful, such termination will be deemed converted to a termination for convenience pursuant to Paragraph 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 Paragraph 14.3.

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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 Date of April 21, 2022, entitled "Patient Care Tower -T1251 - Linear Accelerator Replacement", project number CP212451

b. Architect
Burns & McDonnell Engineering Company, Inc.
9400 Ward Parkway
Kansas City, MO 64114
(816) 822-3155
Michael M. Moser, Project Manager
Email: mmmoser@burnsmcd.com

c. Mechanical & Electrical Engineer
Burns & McDonnell Engineering Company, Inc.
9400 Ward Parkway
Kansas City, MO 64114
615-377-0761
Mechanical – Derek Hunter
Email: dwhunter@burnsmcd.com
423-708-2918
Electrical – Chris Coode
Email: cpcoode@burnsmcd.com
816-447-9938
Electrical – Eric Perry
Email: elperry@burnsmcd.com

d. Structural Engineer
Burns & McDonnell Engineering Company, Inc.
9400 Ward Parkway
Kansas City, MO 64114
816-782-6632
Michael Sartain
Email: msartain@burnsmcd.com

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

2. SPECIAL SCHEDULING REQUIREMENTS

a. Special scheduling requirements supplemental to the bid form:

(1) Contractor shall perform all work in the designated areas outside of regular working hours, which are **7:00** a.m. to **5:00** p.m., Monday through Friday.

(2) Night hours are defined as Monday through Thursday, after 8:00 p.m. and before 4:00 a.m.

(3) Weekend hours are defined as after 5:00 p.m. on Friday until 4:00 a.m. Monday.

(4) Contractor shall coordinate installation of CT, Fluoroscopy and General Radiography equipment by a separate vendor contract.

3. SCOPE OF WORK

a. The Contractor shall furnish all labor, materials, tools, equipment necessary for, and incidental to, construction of this project as indicated on 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 partial renovation of the existing Radiology department. The project includes a new imaging suite and the associated support space. The imaging suite includes (2) CT, Fluoroscopy, General Radiography, and Ultrasound room.

(2) Demolition shall consist of removing all wall, ceilings, and finishes in the project areas. It also includes disconnection of building utilities serving the existing space without disruption to operations to the balance of the facility.

(3) Architectural work shall consist of installation of new sliding doors, flooring patchwork, and installation of upper cabinets.

(4) Structural work shall consist of minor concrete slab modifications and structural components in imaging room ceilings to support ceiling mounted equipment.

(5) Mechanical work shall consist of providing new supply and return air distribution system that ties into existing air handler. The project also includes routing piping to and setting rooftop equipment for equipment cooling.

(6) Electrical work shall consist of existing conduit modifications, new conduit installation and electrical power connections related to the renovated area.

4. LOCATION

a. Work shall be performed under this Contract on campus of the University of Missouri - Columbia, at University Hospital Patient Care 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: 03 30 00 _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 one (1) bound copy and one (1) electronic copy 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).

e. 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

a. 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: The Contractors parking lot on Ashland Road may be utilized for employee parking. Coordinate availability and Permits through the Owner's Representative.

(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) 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.

(4) 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.

(5) 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.

(6) 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.

(7) 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.

c. Storage of materials: The Contractor shall store all materials within project limits. The Contractor shall confine apparatus, materials, and operation of workers to location established by the Owner's Representative. The Contractor shall not unreasonably encumber premises with materials. In addition, storage trailer locations may be available within 1-1/2 miles of project site as directed by the Owner's Representative. Storage trailer locations shall be subject to approval by the Owner's Representative and are available to the Contractor without cost.

d. Utilities: Drinking water, water required to carry on work, and 120 volt electrical power required for small tool operation may be obtained without cost to the Contractor from existing utilities at locations designated by the Owner's Representative. Provisions for obtaining power, including temporary extensions, shall be furnished and maintained by the Contractor. Upon completion of work such extensions shall be removed and any damage caused by use of such extensions shall be repaired to satisfaction of the Owner's Representative, at no cost to the Owner.

e. Restroom: Existing toilet facilities within Project Limits or Restrooms designated by the Owner's Representative for use by the Contractor will be available. Failure of the Contractor to maintain restrooms in a clean condition will be cause for the Contractor's discontinued use of the restroom.

f. Tobacco use 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. **"Permit Required Confined Space" Entry Communication and Coordination**
(See OSHA 1926 subpart aa – Construction Confined Space for the definition of "permit required confined spaces" - Note: OSHA does not apply to the University. However, the University will provide a list of all known "permit required confined spaces")

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 will not be required as a part of work.

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. Substitutions and/or Equals of the item(s) listed below will be allowed only prior to receipt of bids provided that a written 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. All other substitution and/or Equals items shall follow the procedures set forth in the General Conditions.

Item	Specification Section
NA	NA

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.

c. 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.

d. 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 submitted during the bidding period shall be 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.

e. 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.

f. No substitutions and/or equal will be allowed for the following items:

Item	Specification Section
NA	NA

11. CODES AND STANDARDS

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

12. PERMITS

a. The Owner has hired a third-party Code Inspection Agency, George Butler & Associates (GBA) for this project. The Owner will secure a building permit and furnish to the Contractor prior to Construction commencing on site. A temporary Certificate of Occupancy and Certificate of Occupancy process will be incorporated into this project.

b. The Contractor shall be responsible for coordinating inspections with GBA.

c. 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 CRS 40-2.010 through 11 CSR 40-2.065. The permit applications are available at http://www.dfs.dps.mo.gov/programs/bpv/.

13. SPECIALTIES (Not used.)

14. PRE-BID INSPECTION

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

15. ROOF WARRANTY REQUIREMENT

a. Owner has an existing roof warranty on roof of Patient Care Tower 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: Johns Manville
Name:
Roof Type: PVC
Installer: Missouri Builders Service, Inc.
Manufacturer's Warranty: 20 Years
Substantial Completion: January 18, 2013
Expiration Date: January 18, 2033

16. MODIFICATIONS TO INFORMATION TO BIDDERS

(1) Referenced Information to Bidders, Page IFB/5.
Add new Article 15.8.5 as follows:

15.8.5 Within 48 hours of the receipt of bids, the apparent low bidder shall submit to the Director of Facilities Planning and Development an "Affidavit of Supplier Diversity Participation" for every diverse subcontractor or supplier the bidder intends to award work to on the contract. The affidavit will be signed by both the bidder and the diverse firm.

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

a. Information to Bidders:

(1) Referenced Information to Bidders, Page IFB/6.
Add new Article 15.9.2 as follows:
15.9.2.1 Within 48 hours of the receipt of bids, the apparent low bidder shall submit to the Director of Facilities Planning and Development an "Affidavit of Supplier Diversity Participation" for every diverse subcontractor or supplier the bidder intends to award work to on the contract. The affidavit will be signed by both the bidder and the diverse firm.

18. MODIFICATIONS TO GENERAL CONDITIONS (Not Used)

19. PROJECT SCHEDULING

a. 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.

b. Contractor Schedule – Contractor is responsible for the schedule and must comply with the Owner's requirements. 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 **sixty (60)** 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. PROJECT PARTNERING (Not Used.)

22. VALUE ENGINEERING (Not Used.)

23. BUILDING SYSTEM COMMISSIONING

a. Contractor shall provide all personnel and equipment required to complete the commissioning activities referenced in the Commissioning Plan. The requirements of the commissioning plan shall be completed in their entirety before substantial

completion and submitted as referenced in the Closeout Log.

24. 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.

25. COST BREAKOUT FOR OWNER'S ACCOUNTING PURPOSES (Not Used.)

26. PROJECT MANAGEMENT/COMMUNICATION REQUIREMENTS (Not Used.)

27. 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.

28. 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. Unless otherwise instructed by the Owner's Representative, the Contractor shall post a copy of each completed hot work permit to the Owner's project management file system the following business day.

29. GENERAL REQUIREMENTS FOR CRANE AND HOISTING OPERATIONS

a. All crane and hoisting operations shall be performed in compliance with OSHA 29 CFR 1926. All Operators, riggers, and signal persons must have the proper qualifications and training necessary to perform the intended hoisting activities for this project.

b. Only fully certified and evaluated Operators shall perform equipment operations. Operators in an "Operator in Training" status shall not be used.

c. Submittal requirements:

(1) Submit copies of Operator certifications, licenses, and evaluations to the 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.

30. CONSTRUCTION WASTE MANAGEMENT (for projects without a Division 02 specification) (Not used.)

31. WARRANTY WALKTHROUGH

    a. 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

SECTION 1.E.1
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 to 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 SureTrack or P3, Microsoft Project, Oracle P6, or other standard industry scheduling software, approved by the Owner's Representative.
      (2) Schedule Development
      Within 2 weeks of the NTP, contractor shall prepare a schedule, preferably in CPM format, but in detailed bar chart format at a minimum, 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.
o) 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 REQUEST
a) Refer to General Conditions of the Contract for Construction, Article 4.7 Claims for Additional Time.
b) Changes or Other Impacts to the Contractor's Work Plan. The Owner will consider and evaluate requests for time extensions due to changes or other events beyond the control of the Contractor on a monthly basis only, with the submission of the Contractor's updated schedule, in conjunction with the monthly application for payment. The Update must include:
    (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.

END OF SECTION

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SECTION 1.E.2
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: ( )_____

END OF SECTION

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Johns Manville

Peak Advantage Guarantee

PEAK ADVANTAGE Johns Manville

Building Owner:
University of Missouri-Columbia, MO
General Services Building, Planning, Design & Construction 111
Columbia, MO 65211

Building Name:
UMHC PATIENT CARE TOWER - CP070093
MONK DR
COLUMBIA, MO 65201

Guarantee Number: ANP121088738
Expiration Date: January 18, 2033
Job Name: UMHC PATIENT CARE TOWER - CP070093

Approved Roofing Contractor:

MISSOURI BUILDERS SERVICE INC.
PO Box 104205
Jefferson City, MO 65110

Date of Completion: January 18, 2013

Terms & Maximum Monetary Obligation to Maintain a Watertight Roofing System.

Years: 20 Year **$** No Dollar Limit

Coverage:
The components of the Roofing System covered by this Guarantee are:
Total Squares: 472

Sec.	Sqs.	Roof Type	Membrane Spec.	Insulation Type Layer 1	Layer 2	Layer 3	Cover Board
1	472	PVC	SP6RA	Tapered ENRGY 3	None	Securock	

Accessories:

Type	Product Name	Quantity
Expand-O-Flash (1) Style:		lin. ft.
Expand-O-Flash (2) Style:		lin. ft.
Expand-O-Flash (3) Style:		lin. ft.
Drains (1) Style:		ea.
Drains (2) Style:		ea.
Vents Style:		ea.
Fascia Style:		lin. ft.
Copings Style:		lin. ft.
Gravel Stop Style:		lin. ft.

These Johns Manville Guaranteed components are referred to above as the "Roofing System" and ALL OTHER COMPONENTS OF THE OWNER'S BUILDING ARE EXCLUDED FROM THE TERMS OF THIS GUARANTEE, including any amendments thereto.

Johns Manville* guarantees to the original Building Owner that during the Term commencing with the Date of Completion (as defined above), JM will pay for the materials and labor reasonably required in Johns Manville's sole and absolute discretion to repair the Roofing System to return it to a watertight condition if leaks occur due to: ordinary wear and tear, or deficiencies in any or all of the Johns Manville component materials of the Roofing System, or workmanship deficiencies only to the extent they arise solely out of the application of the Roofing System. Non-leaking blisters are specifically excluded from coverage. Should any investigation or inspection reveal the cause of a reported leak to be outside the scope of coverage under this Guarantee, then all such investigation and inspection costs shall be borne solely by the Building Owner.

Johns Manville

A Berkshire Hathaway Company

10100 W Ute Ave (80127)
PO Box 625001
Littleton, CO 80162-5001
800-922-5922
877-403-1747 Fax

Dear Building Owner:

Attached to this letter is the Peak Advantage Roofing Systems Guarantee for the new roof recently installed on your building. We believe your building is now protected by one of the finest commercial roofing systems available on the market today. We appreciate the opportunity to provide you with a level of protection unmatched in the industry.

There are some things you should be aware of before you file this document away in a safe place:

1. This is NOT a maintenance agreement or an insurance policy. Johns Manville liability is strictly governed by the terms of the Guarantee. If you have any questions about this Guarantee, contact Johns Manville Guarantee Services at the appropriate number given below.

2. You are required to perform routine maintenance on the roofing system to keep the coverage to the Guarantee intact. For your convenience, a list of maintenance items is printed on the back of the Guarantee.

We hope that you never experience any difficulty with your roofing system. If you do have a problem, you should contact Johns Manville Guarantee Services at the appropriate numbers provided. Please have the Guarantee on hand so that we may more efficiently handle your inquiry.

Our Technical Services Department is staffed by some of the most experienced roofing professionals in the roofing industry. Please call on them for any questions you might have about commercial and industrial roofing and Johns Manville products.

Sincerely,

Richard Gustin
Manager, Guarantee Services
Johns Manville Roofing Systems Group

(800) 922-5922 www.jm.com gsu@jm.com

WHAT TO DO IF YOUR ROOF LEAKS

If you should have a roof leak please refer to directions on the reverse side. Failure by the Building Owner to comply with any of the directions on the reverse side of this document will render the coverage provided under this Guarantee, including any applicable amendments and/or riders, null and void.

LIMITATIONS AND EXCLUSIONS

This Guarantee is not a maintenance agreement or an insurance policy; therefore, routine inspections and maintenance are the Building Owner's sole responsibility (see reverse side of this document). Failure to follow the Maintenance Program on the reverse side of this document will void the Guarantee in its entirety. This Guarantee does not obligate JM to repair or replace the Roofing System, or any part of the Roofing System, for leaks or appearance issues resulting, in whole or in part, from one or more of the following (a) natural disasters including but not limited to the direct or indirect effect of lightning, flood, hail storm, earthquake, tornados, hurricanes or other extraordinary natural occurrences and/or wind speeds in excess of 55 miles per hour; (b) misuse, abuse, neglect or negligence; (c) installation or material failures other than those involving the component materials expressly defined above as the Roofing System or exposure of the Roofing System components to damaging substances such as oil, fertilizers, or solvents or to damaging conditions such as vermin; (d) any and all (i) changes, alterations, repairs to the Roofing System, including, but not limited to, structures, penetrations, fixtures or utilities (including vegetative and solar overlays) based upon or through the Roofing System as well as any (ii) changes to the Building's usage that are not pre-approved in writing by JM; (e) failure of the Building substrate (mechanical, structural, or otherwise and whether resulting from Building movement, design defects or other causes) or improper drainage; (f) defects in or faulty/improper design, specification construction or engineering of the Building or any area over which the Roofing System is installed; (g) defects in or faulty/improper architectural, engineering or design flaws of the Roofing System or Building, including, but not limited to, design issues arising out of improper climate or building code compliance; or (h) in instances of a recover project, Johns Manville is not responsible for the performance of pre-existing materials that predated the recover. Instead, Johns Manville's sole responsibility in recover systems where JM materials are adhered to existing materials is limited to the installed recover JM Roofing materials up to the wind speed listed herein. Guarantee coverage is limited to replacing recover JM Roofing materials only (and not the pre-existing materials – which is the Owner's responsibility) as required to return the roofing system to a watertight condition due to a claim covered under the terms and conditions herein. Johns Manville is not responsible for leaks, injuries or damages resulting from any water entry from any portion of the Building structure not a part of the Roofing System, including, but not limited to, deterioration of the roofing substrate, walls, mortar joints, HVAC units and all other non-Johns Manville materials and metal components. Moreover, the Building Owner is solely and absolutely responsible for any removal and/or replacement of any overburdens, super-strata or overlays, in any form whatsoever, as reasonably necessary to expose the Roofing System for inspection and/or repair.

This Guarantee becomes effective when (1) it is delivered to Owner; and (2) all bills for installation, materials, and services have been paid in full to the Approved Roofing contractor and to JM. Until that time, this Guarantee is not in force, has no effect – and JM is under no obligation whatsoever to perform any services/work.

The Parties agree that any controversy or claims relating to this Guarantee shall be first submitted to mediation under the Construction Industry Arbitration and Mediation Rules of the American Arbitration Association (Regular Track Procedures) or to such other mediation arrangement as the parties mutually agree. No court or other tribunal shall have jurisdiction until the mediation is completed. In any action or proceeding brought against the Building Owner to enforce this Guarantee or to collect costs due hereunder, Johns Manville shall be entitled to recover its reasonable costs, expenses and fees (including expert witness' fees) incurred in any such action or proceeding, including, without limitation, attorneys' fees and expenses, and the Building Owner shall pay it.

TO THE FULLEST EXTENT PERMITTED BY LAW, JM DISCLAIMS ANY IMPLIED WARRANTY, INCLUDING THE WARRANTY OF MERCHANTABILITY AND THE WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE, AND LIMITS SUCH WARRANTY TO THE DURATION AND TO THE EXTENT OF THE EXPRESS WARRANTY CONTAINED IN THIS GUARANTEE.

THE EXCLUSIVE RESPONSIBILITY AND LIABILITY OF JM UNDER THIS GUARANTEE IS TO MAKE REPAIRS NECESSARY TO MAINTAIN THE ROOFING SYSTEM IN A WATERTIGHT CONDITION IN ACCORDANCE WITH THE OBLIGATIONS OF JM UNDER THIS GUARANTEE. JM AND ITS AFFILIATES WILL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES TO THE BUILDING STRUCTURE (UPON WHICH THE ROOFING SYSTEM IS AFFIXED) OR ITS CONTENTS AND OR OCCUPANTS, LOSS OF TIME OR PROFITS OR ANY INCONVENIENCE, INJURY. JM SHALL NOT BE LIABLE FOR ANY CLAIM MADE AGAINST THE BUILDING OWNER BY ANY THIRD PARTY AND THE BUILDING OWNER SHALL INDEMNIFY AND DEFEND JM AGAINST ANY CLAIM BROUGHT BY ANY THIRD PARTY AGAINST JM RELATING TO OR ARISING OUT OF THE ROOFING SYSTEM OR JM'S OBLIGATIONS UNDER THIS GUARANTEE. JM AND ITS AFFILIATES SHALL NOT BE LIABLE FOR ANY DAMAGES WHICH ARE BASED UPON NEGLIGENCE, BREACH OF WARRANTY, STRICT LIABILITY OR ANY OTHER THEORY OF LIABILITY OTHER THAN THE EXCLUSIVE LIABILITY SET FORTH IN THIS GUARANTEE. THIS GUARANTEE DOES NOT COVER, AND EXPLICITLY EXCLUDES, ANY AND ALL INJURIES, CLAIMS AND/OR DAMAGES RESULTING, IN WHOLE OR IN PART, FROM ANY WATER ENTRY FROM ANY PORTION OF THE BUILDING STRUCTURE INCLUDING, BUT NOT LIMITED TO, THE ROOFING SYSTEM.

No one is authorized to change, alter, or modify the provision of this Guarantee other than the Manager, Guarantee Services or authorized delegate. JM's delay or failure in enforcing the terms and conditions contained in this Guarantee shall not operate as a waiver of such terms and conditions. This Guarantee is solely for the benefit of the Building Owner identified above and Building Owner's rights hereunder are not assignable. Upon sale or other transfer of the Building, Building Owner may request transfer of this Guarantee to the new owner, and JM may transfer this Guarantee, in its sole and absolute discretion only after receiving satisfactory information and payment of a transfer fee, which must be paid no later than 30 days after the date of Building ownership transfer.

In the event JM pays for repairs which are required due to the acts or omissions of others, JM shall be subrogated to all rights of recovery of the Building Owner to the extent of the amount of the repairs.

Because JM does not practice Engineering or Architecture, neither the issuance of this Guarantee nor any review of the Building's construction or inspection of roof plans (or the Building's roof deck) by JM representatives shall constitute any warranty by JM of such plans, specifications, and construction or in any way constitute an extension of the terms and conditions of this Guarantee. Any roof inspections are solely for the benefit of JM.

JM does not supervise nor is it responsible for a roofing contractor's work except to the extent stated herein, and roofing contractors are not agents of JM.

*JOHNS MANVILLE ("JM") is a Delaware corporation with its principal mailing address at P.O. Box 5108, Denver, Colorado 80217-5108.

This guarantee has been amended to include wind speeds up to 60 mph under the terms and conditions herein.

By: Robert Wamboldt
Title: Vice President & General Manager
Roofing Systems Group

Jamie Fredericks
Attorney-in-Fact

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SECTION 1.E.3
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:_____

END OF SECTION

SECTION 1.E.3.1

UNIVERSITY OF MISSOURI

CONTRACTOR'S ROOFING/FLASHING/SHEETMETAL GUARANTEE

WHEREAS Missouri Builders Service, Inc. P.O. Box 104205, Jefferson City, MO 65110 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: Patient Care Tower – Shell & Core-Roofing, Project #CP07009305
Owner: University of Missouri
Columbia, Missouri
Date of Full Completion: January 18, 2013
Approximate Area of Roof: 472 squares
Type of Roofing Material: Johns Manville PVC Spec #SP6RA
Thickness and Type of Roof Insulation: Tapered ENRGY 3 and Securock

NOW, THEREFORE, Roofing Contractor guaranties to the Owner, subject only to the exclusions stated hereinafter, that all roofing, flashing and sheet metal 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 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, and 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 Owners 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 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 at 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 22nd day of February 2013 .

By: Tom M. Caspari

Tom M. Caspari, President

For Roofing Contractor

Name: Missouri Builders Service, Inc.

Address: P.O. Box 104205, Jefferson City, MO 65110-4205

Phone: 573-636-7733

SECTION 1.E.4
SHOP DRAWING AND SUBMITTAL LOG

Project:
Project Number:
Contractor:

Section	Description	Contractor	Date Rec'd	#	Date Sent to Cons.	Date Ret'd	Remarks	Date ret'd	Copies To Cont'r	Owner	File
Drawings	SLIDING DOOR FRAME & TRACK										
02 41 19	SELECTIVE DEMOLITION										
06 10 53	MISCELLANEOUS ROUGH CARPENTRY										
06 41 16	PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS										
06 60 00	PLASTIC FABRICATIONS										
09 22 16	NON-STRUCTURAL METAL FRAMING										
09 29 00	GYPSUM BOARD										
09 51 13	ACOUSTICAL PANEL CEILINGS										
09 65 13	RESILIENT BASE AND ACCESSORIES										
09 65 16	RESILIENT SHEET FLOORING										
09 91 23	INTERIOR PAINTING (MPI STANDARDS)										
10 26 00	WALL AND DOOR PROTECTION										
23 05 19	METERS AND GAGES FOR HVAC PIPING										
23 05 23	GENERAL-DUTY VALVES FOR										

	HVAC PIPING										
23 07 19	HVAC PIPING INSULATION										
23 21 13	HYDRONIC PIPING										
26 05 26	GROUNDING										
26 05 29	HANGERS										
26 05 33	RACEWAYS, BOXES, SLEEVES, SEALS AND FITTINGS FOR ELECTRICAL SYSTEMS										
26 05 48	VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS										
26 05 53	ELECTRICAL IDENTIFICATION										
26 05 73	OVERCURRENT PROTECTIVE DEVICE STUDY										
26 08 00	ELECTRICAL CX REQUIREMENTS										
26 27 26	WIRING DEVICES										
26 28 16	CIRCUIT AND MOTOR DISCONNECT SWITCHES										

SECTION 1.E.5
OPERATING INSTRUCTIONS AND SERVICE MANUAL LOG

Project:
Project Number:
Contractor:

Section	Description	Catalog Data	Wiring Diagrams	Installation Instructions	Service & Maintenance Instructions	Parts List & Availability	Performance Curves	Startup & Operating Instructions
09 65 16	RESILIENT SHEET FLOORING							
10 26 00	WALL AND DOOR PROTECTION							
23 05 19	METERS AND GAGES FOR HVAC PIPING							
23 21 13	HYDRONIC PIPING							
26 08 00	ELECTRICAL CX REQUIREMENTS							

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SECTION 1.E.6
CLOSEOUT LOG

Project:
Project Number:
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.					

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CP221611 MUTH PCT Radiology Expansion Quality Assurance Log

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
1						
Building System Commissioning						
Commissioning Agent - Conduct pre-installation meetings per specifications.					Meeting Minutes	☑
64023						
Interior Architectural Woodwork						
Check all cabinet doors and drawers for smooth operation, correct hardware, fit & finish						☐
Hold Preinstallation conference as specified					Meeting Minutes	☑
78413						
Penetration Firestopping						
Do not enclose firestopping with other construction until inspection has been completed.					Test Report	☑
Help third party perform Field Quality control section of specs					Third Party Field Report	☑
78443						
Joint Firestopping						
Help third party perform Field Quality control section of specs					Third Party Field Report	☑
Hold Preinstallation conference as specified					Meeting Minutes	☑
81416						
Flush Wood Doors						
Hold Preinstallation conference as specified					Meeting Minutes	☑

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
Inspect Fire Tags					Door List	☑
84243						
Intensive Care Unit/Critical Care Unit (ICU/CCU) Entrances						
Hold Preinstallation conference as specified					Meeting Minutes	☑
87111						
Door Hardware						
Check and adjust all latchsets, locksets and exit devices for proper operation per specifications						☐
Perform Demonstration and Training section of specifications					Sign In sheet	☑
Perform Field Quality Control section of specifications					Test Report	☑
Verify door closures comply with ADA requirements						☐
Verify that all fire doors close and latch positively					test report	☐
87113						
Automatic Door Operator						
Hold Preinstallation conference as specified					Meeting Minutes	☑
Automatic Door Operators						
Perform Field Quality Control section of specs					Test Report	☑

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
Provide factory training					Sign in sheet	☑
92116						
Gypsum Board Shaft Wall Assemblies						
Verify fire rating compliance is maintained, including all wall penetrations. Ensure stencil of fire rating is on wall					Inspection Report	☑
92900						
Gypsum Board						
Verify fire rating compliance is maintained, including all wall penetrations. Ensure stencil of fire rating is on wall					Inspection Report	☑
93000						
Tiling						
Hold Pre-installation meetings as specified					Meeting Minutes	☑
Perform Demonstration section of specs					Sign-in Sheet	☑
95113						
Acoustical Panel Ceilings						
Build Mockup as specified					Inspection Report	☑
Complete all above ceiling inspections prior to installation of tiles						☑
Hold Pre-installation meetings as specified					Meeting Minutes	☑

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
96500						
Resilient Flooring						
Conduct Pre-Installation Conference					Meeting Minutes	☑
Insure sub-floor surface has been prepared (ridges & bumps removed; low spots filled; cracks, joints & holes are filled.) and meet specified requirements						☐
Perform Field Quality Control section of specs					Test Report	☑
Perform pH, Chloride (moisture) and bond tests per manufacturer. Do not proceed until all manufacturing requirements are met.					Test Report	☑
96513						
Resilient Base and Accessories						
Hold Pre-installation meetings as specified					Meeting Minutes	☑
96516						
Resilient Sheet Flooring						
Obtain written certification that adhesive is approved by mfr. for specific tile.					written certification	☐
96800						
Carpeting						
Conduct pre-installation testing per specifications					Meeting Minutes	☑
99124						
Interior Painting						
Conduct pre-installation testing per specifications					Meeting Minutes	☑

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
Periodically Check Wet Film Thickness To Assure Conformance With Manufacturer's Requirements To Achieve Dry Film Thickness per Field Quality Control section of spec					field report	☑
102115						
Cubicle Specialties						
Build Mockup as specified					Inspection Report	☑
102613						
Wall and Corner Guards						
Hold Pre-installation meetings as specified					Meeting Minutes	☑
102813						
Toilet Accessories						
Hold Pre-installation meetings as specified					Meeting Minutes	☑
104413						
Fire Protection Cabinets						
Hold Pre-installation meetings as specified					Meeting Minutes	☑
104416						
Fire Extinguishers						
Hold Pre-installation meetings as specified					Meeting Minutes	☑
213113						
Wet-Pipe Sprinkler Systems						
Perform Demonstration section of specifications					Sign In sheet	☑

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
Perform Field Quality Control section of specifications					NFPA 13 Certification	☑
Provide Extra Materials as specified					Transmittal	☑
213116						
Dry Pipe Sprinkler System						
Perform Field Quality Control section of specifications					NFPA Certification	☑
220518						
Escutcheons for Plumbing Piping						
Hold MEP pre-installation meeting(s).					Meeting Minutes and Sign-up Sheet	☑
220519						
Meters and Gages for Plumbing Piping						
Install pete's plugs as specified and as directed by owners representative						☑
220523						
General Duty Valves for Plumbing Piping						
Check valves for leaks and replace in necessary						☐
220719						
Plumbing Piping Insulation						
Verify correct type, thickness and jacket installed						☐
221116						
Domestic Water Piping						
Perform Cleaning section of spec and obtain bacteria test results as specified					Test Results	☑

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
Test piping systems per Field Quality Control section of specifications.					Test Report	☑
Domestic Water Piping Specialties						
Perform Field Quality Control section of specifications.					Test Report	☑
221316						
Sanitary Waste and Vent Piping						
1. Verify rough-in complete prior to slab pour or wall installation						☑
2. Inspect, test and commission per specifications					Test Report	☑
Perform leak test per specifications					test report	☑
221319						
Sanitary Waste and Vent Piping Specialties						
Perform Field Quality Control section of specifications					Test Report	☑
224213						
Commercial Lavatories						
Provide Extra Materials as specified					Transmittal	☑
Commercial Urinals						
Provide Extra Materials as specified					Transmittal	☑
Commercial Water Closets						
Provide Extra Materials as specified					Transmittal	☑

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
224216						
Commercial Sinks						
Provide Extra Materials as specified					Transmittal	☑
224500						
Emergency Plumbing Fixtures						
Perform Field Quality Control section of specifications					Test Report	☑
226113						
Compressed-Air Equipment for Laboratory and Healthcare Facilities						
Provide factory training					Sign in sheet	☑
Compressed-Air Piping for Laboratory and Healthcare Facilities						
Inspect, test and certify per specifications					Test Report	☑
Provide Extra Material as specified					Transmittal	☑
226213						
Vacuum Piping for Laboratory and Healthcare Facilities						
Perform Field Quality Control section of specs					Test Report	☑
Provide Extra Material as specified					Transmittal	☑
Train owner's personnel per specifications					Sign in sheet	☑

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
226313						
Gas Piping for Healthcare Facilities						
Perform Field Quality Control section of specs					field report	☑
Provide Extra Material as specified					Transmittal	☑
Provide factory training					Sign in sheet	☑
226400						
Medical Gas Alarms						
Perform Field Quality Control section of specifications					Test Report	☑
Perform Startup Service section of specifications					Startup Report	☑
Provide factory training					Sign in sheet	☑
230513						
Common Motor Requirements for HVAC Equipment						
Hold MEP pre-installation meeting(s).					Meeting Minutes	☑
Verify basic motor requirements are in accordance with documents					Inspection Report	☑
230518						
Escutcheons for HVAC Piping						
Perform Field Quality Control section of specifications					Test Report	☑

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
230519						
Meters and Gages						
Verify calibration, adjustment and cleanliness of specified meters and gauges						☐
230523						
General Duty Valves for HVAC Piping						
Verify proper valve operators and stems are installed						☐
230548						
Vibration and Seismic Controls for HVAC Piping and Equipment						
Verify inertia bases have specified clearance						☐
230553						
Identification for HVAC Piping and Equipment						
Install pipe markers per specifications						☐
230593						
Contractor Scope for Owner Supplied TAB						
Coordinate and cooperate with owner's commissioning efforts						☐
Hold Pre-Balancing Conference as specified					Meeting Minutes	☑
Notify Owner's Representative 14 days prior to the scheduled date for balancing the system.					written notification	☐
Perform all activities as outlined in spec section 1.02 C.						☐

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
Place outlet dampers in full open position						☐
Provide a complete set of as-builts prior to testing						☐
Supply control diagram					control diagram	☐
230713						
Duct Insulation						
Inspect for pinning in duct insulation					Inspection Report	☑
230716						
HVAC Equipment Insulation						
Perform Field Quality Control section of specs					Test Report	☑
Verify all valve stems and damper shafts are extended and accessible						☐
230719						
HVAC Piping Insulation						
Verify all piping unions are accessible for maintenance						☐
230923						
Direct Digital Control (DDC) System for HVAC						
Check and record amp draw on supply transformers of I/O panels					Test Report	☑
Ensure shipping material has been removed from thermostats and other control devices						☐

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
Post laminated control diagram in mechanical room						☐
Test and adjust temperature controls in coordination with TAB engineer						☐
Verify all field devices provided by contractor are terminated						☐
Verify all panel covers are installed						☐
232113						
Hydronic Piping						
Drain, flush and refill system with clean water.					Flush Report	☑
Test piping per Field Quality Control section of specifications					Test Report	☑
232123						
Hydronic Pumps						
Align pumps to conform with manufacturer's published tolerances					test report	☐
Comply with requirements of "Startup" section of specifications					Startup Report	☑
Flush systems until strainers are clean, change strainers and clean vents						☑
Furnish Extra Material as specified					Transmittal	☑
Perform Demonstration section of specifications					Sign in Sheet	☑

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
232500						
HVAC Water Treatment						
Perform Field Quality Control section of specifications					Test Report	☑
233113						
Metal Ducts						
Perform Field Quality Control Section of specifications. If no other leakage class is specified then use a leakage class of 4					Test Report	☑
233300						
Air Duct Accessories						
Test all fire dampers per NFPA-90A and Field Quality Control section of spec.					Test Report	☑
Verify that all dampers are fully accessible through the access doors for future maintenance and testing					test report	☐
233423						
HVAC Power Ventilators						
Furnish Extra Material as specified					Transmittal	☑
Perform Field Quality Control section of specs.					Test Report	☑
233600						
Air Terminal Units						
Conduct Startup Service per specifications					Test Report	☑
Perform Demonstration section of specs.					Sign in Sheet	☑

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
Perform Field Quality Control section of specs.					Test Report	☑
238219						
Fan Coil Units						
Furnish Extra Material as specified					Transmittal	☑
perform Demonstration section of specifications					Sign In Sheet	☑
perform field quality control section of specifications					Test Report	☑
260510						
Basic Electrical Requirements						
Train all End Users on the equipment they will use on a periodic basis.					Sign-in Sheet	☑
260519						
Low-Voltage Electrical Power Conductors and Cables						
Ensure wires are color coded per specifications						☐
Perform independent tests per "Field Quality Control" section of spec, including megohm/high pot tests					test report	☑
260526						
Grounding						
Perform resistance test as described in Field Quality Control section of spec					test report	☑

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
260543						
Vibration and Seismic Controls for Electrical Systems						
Perform Field Quality Control section of spec					Test Report	☑
260553						
Electrical Identification						
Ensure identification devices are applied per specifications						☐
260573						
Overcurrent Potective Device Studies						
Factory certified technician to set electronic overcurrent devices to approved coordination study setpoints					Inspection Report	☑
Perform 'Testing' section of specifications					Test Report	☑
Place arcflash labels on equipment as specified						☑
SKM data to be e-mailed to MU Commissioning Engineer					SKM Data	☑
Train owners representatives in setting of overcurrent devices					Sign-up Sheet	☑
260923						
Lighting Control Equipment						
Perform personnel training section of spec					Sign-up Sheet	☑
Perform tests per Field Quality Control section of spec					Test Report	☑

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
260936						
Modular Dimming Controls						
Perform Demonstration section of specifications					Sign In Sheet	☑
Perform independent tests per "Field Quality Control" section of spec, including megohm/high pot tests					Test Report	☑
260943						
Network Lighting Controls						
Factory rep shall provide start-up per field quality control section of specs.					field report	☑
Furnish Extra Materials as specified					Transmittal	☑
Perform tests per Demonstration section of spec					Sign In Sheet	☑
262213						
Transformers						
Perform Field Quality Control section of spec					test results	☑
Perform Testing section of spec					Test Report	☑
262300						
Low-Voltage Switchgear						
Furnish Extra Materials as specified					Transmittal	☑
Perform Demonstration section of spec					Sign in Sheet	☑

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
Perform Field Quality Control section of spec					test report	☑
262313						
Paralleling Low-Voltage Switchgear						
Perform tests per Field Quality Control section of spec					Test Report	☑
Perform tests per Training section of spec					Sign In Sheet	☑
262416						
Panelboards						
Perform checks per "Field Quality Control" and "Testing" section of spec					Test Report	☑
Perform Demonstration section of spec					Sign In Sheet	☑
Provide Extra Materials as specified					Transmittal	☑
262713						
Electricity Metering						
Perform checks per "Field Quality Control" section of spec					test report	☑
262726						
Wiring Devices						
Operate All Devices per "Field Quality Control" section of spec to verify correct operation					Test Report	☑

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
262813						
Fuses						
Perform "Field Quality Control" section of spec					Test Report	☐
Test pull-out resistance per specifications						☑
262923						
Variable-Frequency Motor Controllers						
Perform "Field Quality Control" section of spec					Test Report	☑
263213						
Engine Generators						
Perform tests per "Field Quality Control" section of spec. Including load bank testing					Test Report	☑
Provide factory training					Sign In Sheet	☑
263323						
Central Battery Equipment						
Perform all tests as noted in "Field Quality Control" section of spec					field report	☑
Perform Demonstration section of spec					Sign In Sheet	☑
Perform Startup Service section of spec					Startup Report	☑

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
263353						
Static Uninterruptible Power Supply						
Furnish Extra Materials as specified					Transmittal	☑
Perform all tests as noted in "Field Quality Control" section of spec					Test Report	☑
Perform Demonstration section of spec					Sign In Sheet	☑
263600						
Transfer Switch						
Perform all tests as noted in "Field Quality Control" section of spec					Test Report	☑
Perform Demonstration section of spec					Sign In Sheet	☑
264113						
Lightning Protection for Structures						
Provide periodic and final inspections as required by LPI-177 in order to obtain UL Master Label					field report, certification, and Master Label	☑
265100						
Exterior Lighting Fixtures						
Perform Demonstration section of spec					Sign In Sheet	☑
Perform Field Quality Control section of specifications					Test reports	☑
LED Interior Lighting						
Illuminate emergency lights for 90 minutes on battery power.					Test Report	☑

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
Perform Field Quality Control section of specifications					Test Report	☑
271000						
Structured Cabling System						
Furnish Extra Materials as specified					Transmittal	☑
Perform Field Quality Control section of specifications					Test Report	☑
283111						
Digital Addressable Fire - Alarm System						
Furnish Extra Materials as specified					Transmittal	☑
Pretest system and document					Pretest Checklist	☐
Provide factory training					Sign in sheet	☑
Test each system for continuity						☑
Test system operation of pull stations horns/strobes by factory trained representative per Field Quality Control section of spec.					Written certification of fire alarm system per NFP	☑
Verify battery power available						☐
Verify operation of each notification device						☑

Commissioning Items by CSI Division	Verified by: Name	Firm	Date compl	Coord Initial	Documentation Required	Owner Witness Required
337149						
Medium Voltage Cables						
Perform Field Quality Control section of specifications					Test Report	☑

Please see following website for suggested commissioning forms:

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

Section 1.E.8

Healthcare Construction Guideline

(Included for your information on Healthcare projects only)

SEPT 2017 Edition

Table of Contents

Section 1 Training Requirements

The purpose of the training requirements for contractors is to ensure that construction project work in and around the healthcare environment is managed in such a way to minimize health and safety risks associated with construction activities and that contractors know and understand their responsibilities.

Required Training

1. Contractor project managers, superintendents and subcontractor foremen will be required to attend the following training:
    - Minimum of One (1) hour training related to ***"Infection Control & Dust Barriers"*** and "***Healthcare Construction Training for Contractors".***
2. Contractor project managers, superintendents and subcontractor foremen have the responsibility for ensuring that contractor employees are knowledgeable of the training requirements and direct their employees and project work accordingly.
3. Contractors will be required to utilize the MU Hospital online **eMeditrack** system for initiating work requests of various types, examples may include infection control barriers, utility outage, various permits required.
4. Contractors are required to report in and sign in and out at the designated location per building location each work day upon arrival and exit of the work location.

Training Agenda

At a minimum the topics to be covered in the training include the following:

1. Construction Risk Assessment, Infection Control, ventilation, barrier plans and Interim Life Safety.
2. Contractor Training Requirements.

Documentation

1. All employees who receive training will be required to sign their name on a training acknowledgement form stating that they have been oriented to the training requirements.
2. Healthcare Safety and Infection Control Requirements will be in the project contract documents for further review as required.
3. **COMPLIANCE VIOLATIONS:** Contractors/Vendors who violate the requirements of this Guideline are subject to disciplinary action and removal from the project.

Section 2 Emergency Phone Numbers & Contact Information

Telephone contacts should be used by the contractor for emergency situations which may arise during the construction project. Contact Plan will be identified and coordinated at the project Pre-Construction Meeting by the owner's representative.

Section 3 Contractor Identification Badge

Contractors working in and around the MUHC facilities will be required to display and wear the ***"Contractor Identification Badge"*** and in accordance with the information displayed below. 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 ID Badge

1. Contractor is to issue badges to employees as required. (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. Contractor will provide badge holders.
3. Contractor shall keep a roster/log of badged employees by trade/subcontractor at the project jobsite for reference by the Owners Representative.
4. All badges to be collected and returned to PD&C at the end of the project.
5. Any orientation required will be discussed at the pre-construction meeting with the Owner's Representative.
6. Contractor employees are to wear the badge on the upper chest facing forward unless approved otherwise for safety reasons.
7. All contractor superintendent and 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

8. The Badge document will be provided to the Contractor to make copies and distribute as required. See Page HCG 12.

Section 4 General Safety Requirements for Health Care Projects

The General Contractor and its Subcontractors are responsible for understanding, planning and implementing the following requirements in the management of the project.

1. Make sure shoes/boots and clothing are free of excessive dirt/debris before entering and leaving the construction area.
2. If you leave any dust/dirt or tracks in the occupied area of the healthcare facility, you must stop and clean them up immediately by using a HEPA filtered vacuum and/or a clean dampened floor mop with a UMTH hospital approved furnished cleaning solution.
3. Assure that all construction material, supplies and tools are cleaned and covered with a clean covering material while transporting through the healthcare facility.
4. Ensure that the carts and wheels on tool and supply carts as well as trash/demolition waste carts are properly wiped clean before leaving the construction area. Cleaning/wiping solutions are provided by the hospital and must be approved per direction of the Owner's Representative.
5. Staff and patients **ALWAYS** have priority and the **"Right of Way"** in the elevators and corridors.
6. Never use aerosol sprays or cleaning solvents that could dispense fumes, odors or cause potentially allergenic reactions or medical problems to susceptible patients, staff or visitors.

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

The ***"Construction-Renovation-Maintenance Risk Assessment" (CRMRA)*** planning process establishes criteria to be used and measures to be taken for the protection of patients, healthcare workers, visitors and contractors, from construction/renovation activities which could lead to infections or compromise existing life safety systems in the healthcare facility.

Once the Contractor is selected, they will be required, and the Subcontractors as applicable to participate in the ***"CRMRA"*** planning process for orientation of project requirements and help in identifying any additional project needs or risks prior to any contract construction work commencing.

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.

Section 6 Construction – Renovation – Maintenance Infection Control Risk Mitigation Criteria

The ***"Construction–Renovation-Maintenance Infection Control Risk Mitigation Criteria" (CRMICRMC)*** is a process to evaluate construction projects for required interventions during construction in order to minimize Hospital Acquired Infections (HAI's), and controlling dispersal of air and/or water-borne infectious agents concealed within the building components.

All construction activities shall be defined and managed in such a way that occupant's exposure to dust, moisture and their accompanying hazards is limited.

1. ***Construction–Renovation-Maintenance Infection Control Risk Mitigation Criteria*** *and the* ***Construction–Renovation-Maintenance Infection Control Risk Mitigation Permit*** which will be used for all MUHC construction and renovation projects.
2. **Any work required outside the main project limits will require a NEW Infection Control Risk Assessment.**
3. The owner's representatives and Contractor will work together to coordinate the assessment and determine the requirements and permit.
4. The owner's representative will ensure that all required infection control interventions and needed 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.)
5. The contractor shall follow all requirements to support the **"Construction – Renovation- Maintenance Infection Control Risk Mitigation Criteria".**
6. The contract documents and CRM IC Permit will provide requirements specific to the project.

7. *Work outside of construction limits.* Prior to contractor performing any work outside of construction limits, the owner's representative must be notified.
8. Contractors that violate the requirements of the "**Construction – Renovation- Maintenance Infection Control Risk Mitigation Criteria/Permit** will be removed from the project.

Section 7 Construction of Dust Barrier Walls

Infection control is the number one health concern in a construction project. Infection can occur when workers are not cautious about keeping dust, bacteria, mold, etc. from becoming airborne during the construction process. For these reasons, barrier walls are built to isolate dust and fumes in the construction site to separate the patient care and public areas of the healthcare facility.

Dust Barriers Walls and Contamination Reduction

1. A signed copy of the ***"CRM Infection Control Construction Permit"*** shall be kept at the job site at all times. Large AND small projects may have several ***"CRM Infection Control Construction Permits"*** issued as project phases, needs and assessments evolve.
2. Barriers are required to contain the ceiling envelope, chases, interstitial spaces, etc.
3. When access and exiting to the construction site can only be accomplished through a public area, the interior space of the construction site must be cleaned once every 8 – hour shift to control excessive dust and ventilation filtering issues. Debris shall be removed daily.
4. A temporary fire resistant 6 mil., polyethylene dust barrier is required to control dust while the rigid barrier is being constructed as well as at the end of the job during removal of the rigid barrier.
5. Contractors are responsible to ensure that barrier systems and walls are properly constructed, penetrations sealed and maintained for effectiveness for the duration of the project. Anytime polyethylene is used in a control barrier, it must be fire resistant, 6 mil. See ***"Approved Equipment and Product Information".***
6. Once barrier walls are built they are required to be cleaned or wiped down prior to the start of work.
7. Barrier doors and exits from the construction site must be installed with a closer and kept in good working order with positive latching.
8. Keep doors closed except when in use in order to minimize migration of dust and to maintain negative air pressure relationships.
9. Doors must have a seal/door sweep installed at the undercut and weather stripping around the metal frame to control the migration of dust from the construction site.
10. Doors in barrier walls which are not in use by the contractor to the public spaces must be sealed off and taped around the door, frame and threshold undercut, in order to minimize migration of dust and to maintain negative air pressure requirements.
11. If an elevator, dumb waiter, pneumatic tube system, stairway, linen chute, or any other chased or open type building system is located within the construction site, a barrier wall system will be required to be built around the open building system from deck to deck and properly sealed at top, bottom and sidewalls.
12. Upon completion of barriers and prior to beginning work, the contractor shall notify the owner's representative and healthcare construction compliance manager to coordinate an inspection and verify that the barrier wall meets requirements and that acceptable negative air pressure is being achieved.

Special Notes: 1. See ***"Barrier Wall Design Details"*** for additional requirements.
2. See section in this manual on ***"Ventilation and Negative Air Pressure Requirements"*** for additional requirements *when* building dust barrier systems and walls.
3. See section in this manual on ***"Approved Equipment and Product Information"*** .

Section 8 Ventilation and Negative Air Pressure Requirements

The first step is building of dust barrier walls to isolate the construction site from patient care and public areas of the healthcare facility to protect patients and the public from construction related dust, fumes and other activities. The effectiveness of barrier walls is minimal unless the construction site is also under negative air pressure. (i.e. air must flow from clean or public spaces into the dirty or construction site).

The following are the ***"Ventilation and Negative Air Pressure Requirements"*** which contractors shall strictly follow in the management and construction of their projects.

Negative Air Pressure Requirements

1. The contractor shall provide all necessary ***"Negative Air HEPA Filtered Ventilation Units"*** required for the negative air requirements of the construction area.
2. See section in this manual on ***"Approved Equipment and Product Information"*** for more information.
3. The contractor will work with the owner's representative to determine best methods and equipment set up requirements for the project.
4. The contractor shall run the ***"Negative Air HEPA Filtered Ventilation Unit"*** in the work zone location prior to starting any barrier wall construction or work.
5. ***"Negative Air HEPA Filtered Ventilation Units"***, may be connected to normal or emergency power and shall run continuously, 24/7. Critical areas of the healthcare facility may require the HEPA filtered ventilation units to be connected to emergency power only.
6. A secondary method to maintain negative air pressure is by using the hospitals exhaust system attached to the ***"Negative Air HEPA Filtered Ventilation Units"***. This process and installation must be approved by the owner's representative.
7. **Pre-Filters shall be changed at least twice weekly during demolition and drywall sanding and a minimum of once a week during other times.** This frequency requirement may be relaxed for lower risk projects and on prior approval from the owner's representative.
8. The contractor shall furnish and install the negative air-monitoring device to monitor daily negative air pressure ***-.01 inches of water column.*** See section in this manual on ***"Approved Equipment and product Information".***
9. The contractor shall record daily on the ***"Negative Air Pressure and Filter Change Log"*** the air pressure reading in the construction area to insure that appropriate negative air pressure is being maintained.
10. See ***"Negative Air Pressure and Filter Change Log"*** form at the end of this section.

Barrier Walls and Negative Air Ventilation
Special Infection Control Requirements and Interventions for Contractors When Working In (Surgical OR's, Sterile Processing, Bone Marrow Transplant)

Construction activities can lead to increased Aspergillus counts in the air and increased risk for Aspergillus infections in high risk patients. In an effort to minimize and contain dust, and lessen the possibility of microbial contamination during renovation work in high risk special care units, Interventions are typically initiated and maintained until the completion of the project. The owner's representative, MUHC infection control and engineering services departments will be involved in contractor orientation for project work procedures in high risk special care units.

Special work scheduling in these special care units may be a requirement of the project and contractor.

Negative Air Pressure and Filter Change Log

Project Name: _____

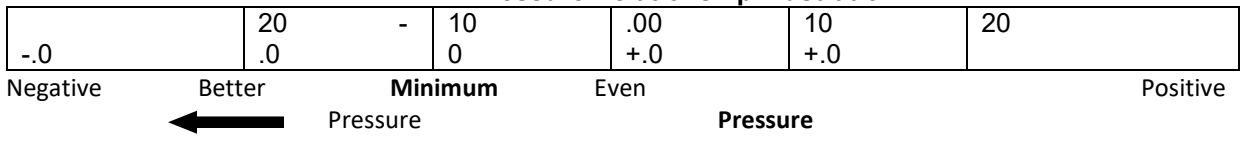
Location: _____

Date:	Time	Negative Air			Unit No.	Inspected By:	Actions Taken (Filter Change, Pre Filter, HEPA, Other)
		Yes	No	Pressure Reading			

Project Number: _____

Contractor to complete the **Negative Air Pressure and Filter Change Log** daily at the start of each work shift and maintain completed forms in the project safety file for future review. Post this log inside construction site entrance for use and review.

Pressure Relationship Illustration



Section 9 Interim Life Safety Measures Assessment (ILSM)

Interim Life Safety Measures (ILSM) are a series of administrative actions that must be taken to compensate temporarily for the hazards posed by existing NFPA Life Safety Code 101, 2014 edition deficiencies, other building code issues or construction activities. Examples of when construction activities require ILSM'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.

Whenever an ***"Interim 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 as well as the contractor.

The contractor has the responsibility prior to the beginning of work and throughout the project to become familiar with the ILSM in order to plan and identify what construction related activities will require an evaluation of ILSM's as noted in the ILSM. The ***"Interim Life Safety Measures Evaluation"*** is a required team effort.

Section 10 Noise and Vibration Control Management

Construction related noise and 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.

Section 11 Above Ceiling Work Permit

All contractors who need access above ceilings in the public areas of the healthcare facility and outside the approved construction site shall be required to obtain an ***"Above Ceiling Work Permit"*** from the owner's representative prior to disrupting or lifting out ceiling tiles. The contractor shall notify the owner's representative fourteen (14) days prior to the need for ceiling access in order to process and evaluate any special requirements of the permit.

General Requirements for Working above Ceilings ("Above Ceiling Permit Required")

1. The Construction-Renovation-Maintenance Infection Control Risk Mitigation Permit issued for the work activity will note specifics required for Barrier Types.
2. Any cable and wiring pulls through the healthcare facility which will require a ceiling disturbance must be approved in advance by obtaining an ***"Above Ceiling Work Permit"***.
3. Ceiling tiles must not be left displaced by the contractor if he walks away from the area unless the area has been contained by an approved ***"Dust Barrier"***.
4. If a ceiling tile is damaged by the contractor he should notify the owner's representative to acquire a new tile for replacement.
5. All debris shall be cleaned up by the contractor daily when working in cabling and electrical closets.
6. Pulling of communication cables in a patient care or other critical care areas will require special scheduling. Consult with the owner's representative for coordination.
7. When cables must be pulled in an active patient care unit, a dust partition must be used at the site of entry and exit of the cable.
8. The dust partition may be attached to the false ceiling because taking it to deck may interfere with the work.
9. The site of entry and exit of the cable or other above ceiling work must be HEPA vacuumed (ceiling tiles and pipes) before the work begins.

Section 12 Lock Out/Tag out Permit

The contractor shall give a minimum fourteen (14) working days) notice to the owner's representative for shutdown work on electrical systems or other critical utility systems which could significantly impact the healthcare facilities operations, **the contractor will be required to plan these "Lock Out/Tag Out" activities ten (14) days in advance.** Major utility shutdowns may require weeks of notice and planning. The contractor shall work with the owner's representative to identify these time planning requirements.

Section 13 Utility Systems Shutdown & Service Permit

The ***"Utility Systems Shutdown & Service Permit"*** is to be used when work on an existing utility system **may cause** a disruption within the MUHC facility.

"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.

Utility Shutdown

Any and all utility or system connections, shut-off, or interruptions must be scheduled with the owner's representative prior to commencement of the work. This work shall be defined as a ***"Utility Shutdown"*** and notice shall be made to the owner's representative to coordinate the request and facilitation.

Utility Service - (System must be worked live or energized)

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 working days' notice** to the owner's representative in order to properly plan and coordinate required activities.

All permits are to be posted at the job site location for the duration of the permit. When complete the contractor shall file the permits in the contractor job safety file for future review as may be required.

Section 14 Hot Work & Permit

Hot work shall be defined as welding, brazing, cutting soldering, grinding, or other activities which produce sparks or use flame which are capable of initiating fires or explosions.

All contractors performing construction, renovation and installation work for MUHC facilities are required to follow the requirements and provisions of **NFPA 51B** and the owner's representative procedures related to "Hot Work" and obtaining a ***"Hot Work Permit"***.

The following are the requirements for a contractor to obtain a ***"Hot Work Permit".***

1. Contractors shall contact the owner's representative two (2) days, forty eight (48) hours in advance to request a hot work permit. A request for complex projects which requires extensive planning on behalf of the owner's representative may require a longer notice period.
2. All hot work sites are inspected by the owner's representative using the requirements printed on the ***"Hot Work Permit".***
3. The owner's representative will issue a ***"Hot Work Permit"*** tag to be attached in the vicinity of the actual hot work being performed. Upon completion, the hot work tag shall be returned to the owner's representative.
4. ***"Hot Work Permits"*** will be issued for only one shift unless other arrangements have been made with owner's representative. All permits expire 30 minutes prior to the end of the shift.
5. If hot work cannot be completed within one work shift, the contractor is responsible for obtaining approval for a revised permit extension from the owner's representative. The contractor is responsible for meeting all the safety requirements required by the permit for any and all extensions granted.
6. The contractor shall be responsible for supplying a trained worker for the requirement of a fire watch during the actual hot work. The fire watch's only responsibility will be as a fire watch.

7. A fire watch shall be provided for 30 minutes following the completion of work, including during lunch and breaks by the contractor.
8. The contractor shall provide at a minimum a ten pound (10) ABC fire extinguisher that has a current, valid inspection tag.
9. A copy of the "***Hot Work Permit"*** shall be kept in the general contractors project file for future review as may be required.
10. The contractor shall upload completed Hot Work Permits to the owner's electronic construction document program (Projex 4) in the Hot Work Permit folder for the project not less than on a weekly basis or as instructed by the owner's representative.

Section 15 Exterior Construction Site Helicopter Landings

Any contractor doing construction work or activities on the hospital grounds, property or on the roof of the buildings is required to follow the guidelines regarding construction activities during helicopter landings on the helipad. The contractor shall coordinate with the owner's representative roof access, roof protection, keying, roof and safety precautions to be taken when working close to the roof edge regarding helicopter landings and contractor responsibilities during this time. 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 ***"Final Approach and Take Off"*** of medical center ambulance helicopters. It is essential that the contractor plans these types of activities with the owner's representative prior to the beginning of work.

Section 16 Required Forms, Permits, Postings and Documentation

Note: Refer to the sections in the "Healthcare Construction Requirements" manual 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 Interim 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				√	
Interim 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

Section 17 Project Cleaning and Barrier Removal Process

The following is the typical sequence prior to the removal of barrier walls.
With the barrier in place and with the ***"Negative Air HEPA Filtered Ventilation Unit"*** running, the contractor will HEPA vacuum all horizontal and vertical surfaces.

1. Clean the covers that are isolating the HVAC ducts.
2. Clean the outside of the negative air HEPA machine and its exhaust duct.
3. The contractor shall notify the owner's representative to schedule a walk-through of the clean space for inspection and approval prior to removal of the barrier wall.
4. Following all job site cleaning and flushing of plumbing, the contractor can begin the barrier cleaning process.

5. During construction or removal of barrier walls, fire resistant polyethylene barriers must be put into place to help control any construction or demolition dust of the barrier wall system.
6. MUHC must approve removal of any Infection Control or other barriers. Prior to removal of the temporary fire resistant polyethylene barrier, it shall be vacuumed with a HEPA vacuum to eliminate any dust attached to the plastic. The polyethylene barrier is then wiped down with the use of damp cleaning cloths and using a hospital furnished approved infection control cleaning solution. The contractor shall roll or fold the polyethylene in on itself creating as little dust as possible prior to transporting out of the building in a covered cart.
7. Remove the covers or caps from any and all HVAC system supply, return and exhaust ducts and restore the HVAC system.
8. The ***"Negative Air HEPA Filtered Ventilation Unit"*** is removed from the project site once the HVAC system is verified is operating properly.

If Air Sampling Is Required
When construction/renovation is done and completed in or near a high risk assessment critical care unit (i.e. Burn Unit, Operating Rooms, Intensive Care, etc.) there may be a requirement to do air sampling after the negative air system has been removed and the building HVAC system has been restored. This will be a requirement only if the infection control department determines the need at the end of the project and prior to occupancy.

Section 18 Approved Equipment and Product Information

"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

"HEPA VACUUM", A shop style vacuum with a 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.

"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. 1300 W. Steel Road, No. 2 Morrisville, PA 19067 (215) 295-8208 or (877) 646-8208.

"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.

- 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. 2067 Wineridge Place. Suite F Escondido, CA 92029. 800-747-6095 Dept. 48. Or approved equal.

Example of Badge for Contractor use -

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 badges, 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.

SECTION 19 Health Care Construction Cleaning Definitions

Construction Clean

1. Remove tools & equipment from the work area.
2. Remove all bulk 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, window sills, 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

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, window sills, 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

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.

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SECTION 1.F
INDEX OF DRAWINGS

Drawings referred to in and accompanying Project Manual consist of following sheets **dated October 11, 2022.**

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Sheet 3 of 13: G-102 - LEVEL 1 - LIFE SAFETY PLAN - PHASE 1
Sheet 4 of 13: G-103 - LEVEL 1 - LIFE SAFETY PLAN - PHASE 2A
Sheet 5 of 13: G-104 - LEVEL 1 - LIFE SAFETY PLAN - PHASE 2
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END OF SECTION

Missouri
Division of Labor Standards
WAGE AND HOUR SECTION

MICHAEL L. PARSON, Governor

Annual Wage Order No. 29

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 10, 2022**

Last Date Objections May Be Filed: **April 11, 2022**

Prepared by Missouri Department of Labor and Industrial Relations

Building Construction Rates for
BOONE County

Section 010

OCCUPATIONAL TITLE	**Prevailing Hourly Rate
Asbestos Worker	$58.66
Boilermaker	$30.87*
Bricklayer	$51.43
Carpenter	$48.35
Lather	
Linoleum Layer	
Millwright	
Pile Driver	
Cement Mason	$41.91
Plasterer	
Communications Technician	$55.88
Electrician (Inside Wireman)	$55.87
Electrician Outside Lineman	$75.58
Lineman Operator	
Lineman - Tree Trimmer	
Groundman	
Groundman - Tree Trimmer	
Elevator Constructor	$30.87*
Glazier	$47.32
Ironworker	$62.10
Laborer	$41.12
General Laborer	
First Semi-Skilled	
Second Semi-Skilled	
Mason	$48.56
Marble Mason	
Marble Finisher	
Terrazzo Worker	
Terrazzo Finisher	
Tile Setter	
Tile Finisher	
Operating Engineer	$60.81
Group I	
Group II	
Group III	
Group III-A	
Group IV	
Group V	
Painter	$37.40
Plumber	$67.36
Pipe Fitter	
Roofer	$52.11
Sheet Metal Worker	$53.28
Sprinkler Fitter	$62.30
Truck Driver	$30.87*
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 Section 290.210 RSMo.

Heavy Construction Rates for
BOONE County

Section 010

OCCUPATIONAL TITLE	**Prevailing Hourly Rate
Carpenter	$51.63
Millwright	
Pile Driver	
Electrician (Outside Lineman)	$75.58
Lineman Operator	
Lineman - Tree Trimmer	
Groundman	
Groundman - Tree Trimmer	
Laborer	$46.46
General Laborer	
Skilled Laborer	
Operating Engineer	$58.48
Group I	
Group II	
Group III	
Group IV	
Truck Driver	$30.87*
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. 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 Section 290.210 RSMo.

OVERTIME
and
HOLIDAYS

OVERTIME

For all work performed on a Sunday or a holiday, not less than twice (2x) the prevailing hourly rate of wages for work of a similar character in the locality in which the work is performed or the public works contracting minimum wage, whichever is applicable, shall be paid to all workers employed by or on behalf of any public body engaged in the construction of public works, exclusive of maintenance work.

For all overtime work performed, not less than one and one-half (1½) the prevailing hourly rate of wages for work of a similar character in the locality in which the work is performed or the public works contracting minimum wage, whichever is applicable, shall be paid to all workers employed by or on behalf of any public body engaged in the construction of public works, exclusive of maintenance work or contractual obligation. For purposes of this subdivision, **"overtime work"** shall include work that exceeds ten hours in one day and work in excess of forty hours in one calendar week; and

A thirty-minute lunch period on each calendar day shall be allowed for each worker on a public works project, provided that such time shall not be considered as time worked.

HOLIDAYS

January first;
The last Monday in May;
July fourth;
The first Monday in September;
November eleventh;
The fourth Thursday in November; and
December twenty-fifth;

If any holiday falls on a Sunday, the following Monday shall be considered a holiday.

SECTION 01 78 46.13 - EXTRA STOCK AND MAINTENANCE MATERIALS - ARCHITECTURAL

PART 1 - GENERAL

1.01 SUMMARY:

A. SECTION Includes: Extra stock and maintenance material requirements for contract closeout.

1.02 SUBMITTALS:

A. Extra Stock and Maintenance Materials: Furnish maintenance materials, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Owner. Label with manufacturer's name and model number.

1. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Owner’s signature for receipt of submittals.

1.03 DELIVERY, STORAGE, AND HANDLING:

A. Store materials in containers and packaging as recommended by manufacturer.

PART 2 - PRODUCTS

2.01 SCHEDULE OF EXTRA STOCK AND MAINTENANCE MATERIALS:

A. 09 30 00 - TILING:

1. Tile and Trim: 5%, amount installed, each type, composition, color, pattern, and size.

B. 09 51 13 - ACOUSTICAL PANEL CEILINGS:

1. Ceiling Panels: 5%; amount installed, full size units.

C. 09 65 00 - RESILIENT FLOORING:

1. Resilient Tile Flooring: 5% of amount installed, each type, color, pattern, class, wearing surface, and size.
2. Resilient Sheet Flooring: 5% in roll form and full roll width of amount installed, each color, pattern, and type.

D. 09 68 00 - CARPETING:

1. Tile Carpeting: 5%; amount installed, full-size units, each color and type.

E. 09 72 00 - WALL COVERING:

1. Wall Covering: 5%; amount installed, full-size units, each type.

PART 3 - EXECUTION (NOT USED)

END OF SECTION 01 78 46.13

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SECTION 02 41 19 – SELECTIVE 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. Demolition and removal of selected portions of building or structure.
   2. Salvage of existing items to be reused or recycled.

1.03 REFERENCED STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
B. The American Society of Safety Engineers:
   1. ANSI/ASSE A10.6 - Safety & Health Program Requirements for Demolition Operations.
C. Code of Federal Regulations:
   1. 40 CFR 82 - Protection of Stratospheric Ozone.
D. National Fire Protection Association:
   1. NFPA 241 - Safeguarding Construction, Alteration, and Demolition Operations.
E. Resilient Floor Covering Institute:
   1. Recommended Work Practices for the Removal of Resilient Floor Coverings.

1.04 DEFINITIONS:

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

1.05 MATERIALS OWNERSHIP:

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

1.06 PREINSTALLATION MEETINGS:

A. Predemolition Conference: Conduct conference at Project site.
   1. Inspect and discuss condition of construction to be selectively demolished.
   2. Review structural load limitations of existing structure.

3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
5. Review areas where existing construction is to remain and requires protection.

1.07 SUBMITTALS:

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

1.08 QUALITY ASSURANCE:

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

1.09 FIELD CONDITIONS:

A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
   1. Before selective demolition, Owner will remove the following items:
      a. Fixtures, furniture, and equipment.
C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
   1. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.
E. Storage or sale of removed items or materials on-site is not permitted.

F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
   1. Maintain fire-protection facilities in service during selective demolition operations.

1.10 WARRANTY:

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties. Notify warrantor before proceeding.

B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

1.11 COORDINATION:

A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.

C. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.
   1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

D. Survey of Existing Conditions: Record existing conditions by use of measured drawings and preconstruction photographs or video.
   1. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.

3.02 PREPARATION:

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

3.03 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS:

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
2. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
3. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.
    a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
    b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
    c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
    d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
    e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
    f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
    g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

3.04 PROTECTION:

A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
4. Cover and protect furniture, furnishings, and equipment that have not been removed.

B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

1. Strengthen or add new supports when required during progress of selective demolition.

C. Remove temporary barricades and protections where hazards no longer exist.

3.05 SELECTIVE DEMOLITION, GENERAL:

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

B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

C. Removed and Salvaged Items:
   1. Clean salvaged items.
   2. Pack or crate items after cleaning. Identify contents of containers.
   3. Store items in a secure area until delivery to Owner.
   4. Transport items to Owner's storage area designated by Owner.
   5. Protect items from damage during transport and storage.

D. Removed and Reinstalled Items:
   1. Clean and repair items to functional condition adequate for intended reuse.
   2. Pack or crate items after cleaning and repairing. Identify contents of containers.
   3. Protect items from damage during transport and storage.
   4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

E. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.06 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS:

A. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, and then remove concrete between saw cuts.

B. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, and then break up and remove.
C. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings." Do not use methods requiring solvent-based adhesive strippers.

3.07 DISPOSAL OF DEMOLISHED MATERIALS:

A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.
   1. Do not allow demolished materials to accumulate on-site.
   2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
   3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
B. Burning: Do not burn demolished materials.

3.08 CLEANING:

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

END OF SECTION 02 41 19

SECTION 06 10 53 – MISCELLANEOUS ROUGH CARPENTRY

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. Framing with dimension lumber.
   2. Wood blocking and nailers.
   3. Plywood backing panels.

1.03 RELATED REQUIREMENTS:

1.04 REFERENCED STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
B. American Wood Protection Association:
   1. AWPA M4 - Care of Preservative-Treated Wood Products.
C. ASTM International:
   1. ASTM A 153/A 153M - Specification for Zinc-Coating (Hot-Dip) of Iron and Steel Hardware.
   2. ASTM B 633 - Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
   3. ASTM C 1002 - Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
   4. ASTM D 5664 - Test Method for Evaluating the Effects of Fire-Retardant Treatments and Elevated Temperatures on Strength Properties of Fire-Retardant Treated Lumber.
   5. ASTM E 84 - Test Method for Surface-Burning Characteristics of Building Materials.
D. ICC Evaluation Service, LLC:
   1. ICC-ES AC01 - Expansion Anchors in Masonry Elements.
   2. ICC-ES AC70 - Acceptance Criteria for Power-Actuated Fasteners Driven into Concrete, Steel, and Masonry Elements.
   3. ICC-ES AC193 - Mechanical Anchors in Concrete Elements.
E. International Code Council:
   1. International Building Code.
F. National Lumber Grades Authority:
   1. Standard Grading Rules for Canadian Lumber.
G. Northeastern Lumber Manufacturers' Association:
   1. Standard Grading Rules for Northeastern Lumber.
H. Redwood Inspection Service:
   1. Standard Specifications for Grades of California Redwood Lumber.
I. The Southern Pine Inspection Bureau:
   1. Standard Grading Rules for Southern Pine Lumber.
J. U.S. Department of Commerce, National Institute of Standards and Technology:
   1. DOC PS 1 - Structural Plywood.
   2. DOC PS 20 - American Softwood Lumber Standard.
K. West Coast Lumber Inspection Bureau:
   1. Standard No. 17 - Grading Rules for West Coast Lumber.

L. Western Wood Products Association:
   1. Western Lumber Grading Rules.

1.05 DEFINITIONS:
A. Boards or Strips: Lumber of less than 2 inches nominal (38 mm actual) size in least dimension.
B. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) or greater size but less than 5 inches nominal (114 mm actual) size in least dimension.

1.06 SUBMITTALS:
A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
   1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
   2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
   3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
   4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
B. Evaluation Reports: For the following, from ICC-ES:
   1. Fire-retardant-treated wood.
   2. Power-driven fasteners.
   3. Post-installed anchors.

1.07 QUALITY ASSURANCE:
A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.08 DELIVERY, STORAGE, AND HANDLING:
A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.01 WOOD PRODUCTS, GENERAL:
A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
   1. Factory mark each piece of lumber with grade stamp of grading agency.
   2. Dress lumber, S4S, unless otherwise indicated.

B. Maximum Moisture Content of Lumber: 19 percent for 2-inch nominal (38-mm actual) thickness or less; no limit for more than 2-inch nominal (38-mm actual) thickness unless otherwise indicated.

2.02 FIRE-RETARDANT-TREATED MATERIALS:

A. General: Where fire-retardant-treated materials are indicated, materials shall comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.
   1. Treatment shall not promote corrosion of metal fasteners.
   2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.

C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Kiln-dry plywood after treatment to a maximum moisture content of 15 percent.

D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.

E. Application: Treat all miscellaneous carpentry unless otherwise indicated.

2.03 MISCELLANEOUS LUMBER:

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
   1. Blocking.
   2. Nailers.
   3. Rooftop equipment bases and support curbs.

B. Dimension Lumber Items: Construction or No. 2 grade lumber of any species.

C. Concealed Boards: 19percent maximum moisture content of and species and No. 2 grade.

D. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

2.04 PLYWOOD BACKING PANELS:

A. Equipment Backing Panels: Plywood, DOC PS 1,, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch (19-mm) nominal thickness.

2.05 FASTENERS:

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
   1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

B. Screws for Fastening to Metal Framing: ASTM C 1002, length as recommended by screw manufacturer for material being fastened.

C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
D. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 ICC-ES AC193 or as appropriate for the substrate.
   1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL:

A. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry accurately to other construction. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.
B. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.
C. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
   1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches (406 mm) o.c.
D. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
E. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
   1. Use inorganic boron for items that are continuously protected from liquid water.
   2. Use copper naphthenate for items not continuously protected from liquid water.
F. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
   1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
   2. ICC-ES evaluation report for fastener.

3.02 WOOD BLOCKING AND NAILER INSTALLATION:

A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.

3.03 PROTECTION:

A. Protect miscellaneous rough carpentry from weather. If, despite protection, miscellaneous rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 06 10 53

SECTION 06 40 23 - INTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.01 SUMMARY:

A. SECTION Includes: Shop-finished interior architectural woodwork and supplementary items necessary for installation.

1.02 DEFINITIONS:

A. Interior architectural woodwork includes wood furring, blocking, shims, and hanging strips for installing woodwork items unless concealed within other construction before woodwork installation.

B. Exposed Surfaces, Semi-Exposed Surfaces, Concealed Surfaces, Types of Cabinet Construction, and other related terms are defined in referenced quality standards.

1.03 ACTION SUBMITTALS:

A. Product Data: Manufacturer's technical literature for each product and system indicated.
   1. Include manufacturer's specifications for materials, finishes, construction details, installation instructions, and recommendations for maintenance.
   2. Fire Retardant Treated Wood: Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.

B. Shop Drawings: Show details of fabrication and installation, including plans, elevations, sections, details of components and attachments to other work. Distinguish between shop and field-assembled work.
   1. Show details to scale.
   2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
   3. Show locations and sizes of cutouts and holes for plumbing fixtures, faucets, soap dispensers, and other items installed in architectural woodwork.
   4. Show grain direction.

C. Samples for Verification:
   1. Items with Plastic Laminate Finish:
      a. Plastic laminates, 8 in by 10 in (200 mm by 250 mm), for each type, color, pattern, and surface finish, with 1 sample applied to core material and specified edge material applied to 1 edge.
   2. Simulated Stone Trim: 6 in (150 mm) long.
   3. PVC Edge Banding.
   4. Solid surfacing materials.
   5. Cabinets:
      a. Corner Piece: Cabinet-front frame joints between stiles and rails, as well as exposed end pieces, 18 in (450 mm) high by 18 in (450 mm) wide by 6 in (150 mm) deep.
      b. Cabinet Hardware and Accessories: Exposed cabinet hardware and accessories, one unit for each type and finish.
      c. Countertops: Section of countertop showing top, front edge, and backsplash construction.
   6. Standing and Running Trim: Corner piece showing miter joints.

1.04 INFORMATIONAL SUBMITTALS:

A. Manufacturer's Project Acceptance Document: Certification by the manufacturer that its product(s) are approved, acceptable, suitable for use in specific locations, for specific details, and for applications indicated, specified, or required, and that a warranty will be issued.

B. Qualification Data:

1. For firms and persons specified in "Quality Assurance" to demonstrate their capabilities and experience. Include list of completed projects.

1.05 QUALITY ASSURANCE:

A. Installer Qualifications:

1. Experience: Installer's personnel with not less than 5 years of experience in the successful performance of Work similar to scope of this Project.
2. Supervision: Installer shall maintain a competent supervisor at Project while the Work is in progress, and who has not less than 5 years of experience installing products and systems similar to scope of this Project.

B. Quality Standard: Unless otherwise indicated, comply with "Architectural Woodwork Standards" for standards and for grades of interior architectural woodwork indicated for construction, finish, installation and other requirements:

1. Provide manufacturer certification indicating that woodwork complies with requirements of referenced quality standards.
2. The Contract Documents contain selections chosen from options in the quality standard and additional requirements beyond those of the quality standard. Comply with such selections and requirements in addition to the quality standard.

C. Fire-Test-Response Characteristics: Where fire-retardant materials or products are indicated or required, provide materials and products with specified fire-test-response characteristics as determined by testing identical products per test method indicated by UL, ITS, or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify with appropriate markings of applicable testing and inspecting agency in the form of separable paper label or, where required by authorities having jurisdiction, imprint on surfaces of materials that will be concealed from view after installation.

D. Mock-ups: Prior to fabrication and installation, build mock-up for each form of construction and finish required to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution. Build mock-up using materials indicated for the completed Work.

1. Build mock-up in the location and of the size indicated or, if not indicated, as directed by Architect. Contractor shall provide structural support framework.
   a. Show typical components, attachments to building structure, and requirements of installation.
2. Notify Architect seven days in advance of the dates and times when mock-up will be installed.
3. Obtain Architect's acceptance of mock-ups before starting fabrication or installation.
4. Acceptance of mock-ups does not constitute acceptance of deviations from the Contract Documents contained in mock-ups unless such deviations are specifically noted by Contractor and accepted by Architect in writing.
5. Demolish and remove mock-ups when directed by Architect unless accepted to become part of the completed Work.

E. Mock-ups, Cabinets:

1. One full-size sample of finished base cabinet unit complete with hardware, doors, and drawers, but exclusive of countertop.
2. One full-size sample of finished wall-mounted cabinet unit complete with hardware, doors, and adjustable shelves.
3. One full-size sample of a caregiver desk (C. Nurse T4577), complete with hardware, lighting, doors/drawers & shelves.
4. Accepted sample units will be used as a standard for judging the completed work. Unless otherwise directed, accepted sample units may be incorporated in work. If not incorporated in work, retain accepted sample units at Project site until completion of work and remove sample units from premises when directed by Architect.

1.06 PRE-INSTALLATION CONFERENCE:

A. Pre-Installation Conference: Before Work begins, conduct conference at Project site.
   1. Participants:
      a. Architect.
      b. Contractor, including superintendent.
      c. Installer, including project manager and supervisor.
      d. If requested, Manufacturer's qualified technical representative.
      e. Installers of other construction interfaced with Work.
   2. Minimum Agenda: Installer shall demonstrate understanding of the Work required by describing detailed procedures for preparing, installing, and cleaning the Work. Demonstration shall include, but not be limited to, following topics:
      a. Tour representative areas of Work, inspect and discuss condition of substrate, and other preparatory work performed by other trades.
      b. Review Contract Document requirements.
      c. Review approved submittals.
      d. Review inspection and testing requirements.
      e. Review environmental conditions and procedures for coping with unfavorable conditions.
      f. Resolve deviations or differences between Contract Documents and the manufacturer's specifications.
   3. Record discussions, including decisions and agreements, and prepare report.

1.07 DELIVERY, STORAGE, AND HANDLING:

A. Do not deliver woodwork until painting and similar operations that could damage woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.

1.08 PROJECT CONDITIONS:

A. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

B. Field Measurements: Where products and systems are indicated to fit walls and other construction, verify dimensions by field measurements before fabrication.
   1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed, and indicate measurements on Shop Drawings.

1.09 COORDINATION:

A. Coordinate installation of products and systems with interfacing and adjoining construction to provide a successful installation without failure.

B. Coordinate Shop Drawings and fabrication with hardware requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS AND PRODUCTS:

A. Acceptable Manufacturers and Products: Subject to compliance with requirements of Contract Documents as judged by the Architect, provide product by one of manufacturers listed. If not listed, submit as substitution according to the Conditions of the Contract and DIVISION 01 SECTION "SUBSTITUTION PROCEDURES".

B. Basis of Design (Product Standard): Contract Documents are based on products and systems specified to establish a standard of quality. Other manufacturers offering products having equivalent characteristics may be considered, provided deviations are minor and comply with requirements of Contract Documents as judged by the Architect.

2.02 MATERIALS, GENERAL:

A. Single Source Responsibility: Furnish each type of product from single manufacturer. Provide secondary materials only as recommended by manufacturer of primary materials.

B. Provide materials that comply with requirements of "Architectural Woodwork Standards" quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.

C. Marine Grade Plywood cores are to be used for all countertops with sinks.

D. Marine Grade Plywood cores are to be used for all base cabinets / aprons where countertops have sinks.

2.03 MATERIALS:

A. Fire Retardant Wood Products for Paneling:

1. Medium-Density Fiberboard: ANSI A208.2, minimum Grade 130-MR50, made with binder containing no added urea formaldehyde.
2. Particleboard: ANSI A208.1, Industrial Grade M-2 Exterior Glue, made with binder containing no added urea-formaldehyde, 43 pcf (753kgm3) Density.
3. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1, made with adhesive containing no added urea-formaldehyde.

B. Wood Products for Cabinets:

1. Medium-Density Fiberboard: ANSI A208.2, minimum Grade 130-MR50, made with binder containing no added urea formaldehyde.
2. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1, made with adhesive containing no added urea-formaldehyde.
3. Softwood Plywood: DOC PS 1.
4. Marine Grade Plywood: PS-1-95, made with adhesive containing no added urea-formaldehyde.

C. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or, if not indicated, as required by woodwork quality standard.

1. Fire-Rated Laminates: Where indicated or scheduled; NEMA LD 3, grades as follows:
   a. Vertical Surfaces: General Purpose Type 604 (VGF), 0.032 in (0.79 mm) thick.
   Horizontal Surfaces: General Purpose Type 605 (HGF) 0.048 in (1.2 mm) thick.

2. Colors, Patterns, and Finishes:
   a. Selections: As scheduled or as indicated in Design Selections.

D. Simulated Stone Trim:
1. Solid Surface Material: Homogeneous solid pieces of filled plastic resin complying with ANSI SS1.
2. Colors, Patterns, and Finishes:
   a. Selections: As scheduled or as indicated in Design Selections.

E. Glass:
1. Tempered Float Glass for Cabinet Doors: ASTM C 1048, Kind FT, Condition A, Type I, Class 1 (clear), Quality-Q3, 6 mm thick, unless otherwise indicated.

2.04 FIRE-RETARDANT-TREATED MATERIALS:

A. General: Where fire-retardant-treated materials are indicated or required, use materials complying with requirements in this Article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified.
1. Do not use treated materials that do not comply with requirements of referenced woodworking standard or that are warped, discolored, or otherwise defective.
2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
3. Identify fire-retardant-treated materials with appropriate classification marking of UL, U.S. Testing, Timber Products Inspection, or another testing and inspecting agency acceptable to authorities having jurisdiction.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Comply with performance requirements of AWPA C20 (lumber) and AWPA C27 (plywood). Use the following treatment types:
1. Exterior Type: Organic-resin-based formulation thermally set in wood by kiln drying.
2. Interior Type A: Low-hygroscopic formulation.
3. Mill lumber before treatment and implement special procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of treated woodwork.
4. Kiln-dry materials before and after treatment to levels required for untreated materials.

C. Fire-Retardant Particleboard: Panels complying with the following requirements, made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 25 or less per ASTM E 84.

D. Fire-Retardant Fiberboard: Medium-density fiberboard panels complying with ANSI A208.2, made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less per ASTM E 84.

2.05 CABINET HARDWARE AND ACCESSORIES:

A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets, except for items specified in DIVISION 08 SECTION "DOOR HARDWARE (SCHEDULED BY DESCRIBING PRODUCTS)."

B. Hinges: Provide number of hinges recommended by hinge manufacturer for size and weight of door.

C. Butt Hinges: 2-3/4 in (69 mm), 5-knuckle steel hinges made from 0.095 in (2.4 mm) thick metal, and as follows:
   1. Semi-concealed Hinges for Flush Doors: BHMA A156.9, B01361.
   2. Semi-concealed Hinges for Overlay Doors: BHMA A156.9, B01521.
   3. Product Standard: Rockford Process Control 32 mm Series

D. Back-Mounted Pulls: BHMA A156.9, B02011.

E. Wire Pulls: Back mounted, solid metal, 4 in (100 mm) long, 5/16 in (8 mm) in diameter.
   1. Product Standard: EPCO-MC-402-4, 4 in (100 mm) center to center of screws, 1-5/16 in (34 mm) projection, 5/16 in (8 mm) diameter. Stainless steel.

F. Catches: Magnetic catches, BHMA A156.9, B03141.

G. Adjustable Shelf Standards and Supports: BHMA A156.9, B04071; with shelf rests, B04081.

H. Shelf Rests: BHMA A156.9, B04013; metal.
   1. Product Standard: K & V No. 345, nickel plated.

I. Drawer Slides: BHMA A156.9, B05091.
   1. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Side mounted; full-extension type; zinc-plated steel ball-bearing slides.
   2. Box Drawer Slides: Grade 1HD-100; for drawers not more than 6 in (150 mm) high and 24 in (600 mm) wide.
      a. Product Standard for 24 in (600 mm) Wide and Less: Full extension; Accuride "7434".

      Product Standard for Wider than 24 in (600 mm): Full extension; Accuride "7432".
   3. File Drawer Slides: Grade 1HD-200; for drawers more than 6 in (150 mm) high or 24 in (600 mm) wide.
      a. Product Standard for 42 in (1050 mm) Wide and Less: Full extension with 1 in (25 mm) over travel; Accuride "3640".

J. Door Locks: BHMA A156.11, E07121.
   1. Product Standard: CompX National Stock Locks, pin tumbler cylinder cam lock Master keyed to E041A, nickel plated.

K. Drawer Locks: BHMA A156.11, E07041.
   1. Product Standard: CompX National Stock Locks, pin tumbler cylinder cam lock Master keyed to E041A, nickel plated.

L. Electronic Door Locks:
   1. Product Standard: Accuride; A10EL series.

M. Electronic Drawer Locks:
   1. Product Standard: Accuride; Senseon Secure Access 10EL drawer catch.

N. Z-Clips:
   1. Product Standard: Hafele Keku 262.49.356

O. Brackets & Standards:
   1. Product Standard: Knape & Vogt, heavy duty, 82/182
   2. Depths are identified in the drawings.

P. File Drawer File Frame System:
   1. Product Standard: Hafele 422.74.310

Q. Grommets for Cable Passage through Countertops: Molded-plastic grommets and matching plastic caps with slot for wire passage.
   1. Size: 1-1/4 in (32-mm) or 2 in (50 mm) OD as indicated.
   2. Color: As indicated.
   3. Product Standards: Doug Mockett & Company, Inc “OG or SG Series” or Hafele 429.93.

R. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.
   1. Satin Stainless Steel: BHMA 630, unless otherwise indicated.

S. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

T. Manufacturers:
   1. Accuride.
   2. Julius Blum, Inc.
   3. The Engineered Products Company.
   4. Grass America, Inc.
   5. Hafele America Company.
   6. Hettich America Corporation.
   7. Knape & Vogt Manufacturing Company (K & V).
   8. Stanley Hardware, Division of the Stanley Works.
   9. CompX National
   10. Monarch

U. Cabinet Accessories:
   1. Counter Support Brackets: Unless noted otherwise, provide brackets factory-primed for field painting.
      a. Manufacturers and Products:
         1) A&M Hardware, Inc.; Work Station Brackets.
         2) Rakks/Rangine Corporation; Counter Support Brackets, EH Series.

2.06 MISCELLANEOUS MATERIALS:

A. Furring, Blocking, Shims, and Hanging Strips: Fire-retardant-treated softwood lumber, kiln dried to less than 15 percent moisture content.

B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

C. Adhesives:
   1. General: As recommended by woodwork fabricator to suit application.
   2. VOC Limits for Installation Adhesives and Glues: Use installation adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24) unless indicated otherwise:
      a. Wood Glues: 30 g/L.
      Contact Adhesive: 250 g/L.
   3. Adhesive for Bonding Plastic Laminate Faces and Edges: PVA as recommended by woodwork fabricator to suit application.

D. Hanging Clips: Provide manufacturer's standard nonferrous-metal or hot-dip galvanized zee hanging clips.

2.07 FABRICATION, GENERAL:

A. Interior Woodwork Grade: Unless otherwise indicated, provide Premium Grade interior woodwork complying with referenced quality standard.

B. Wood Moisture Content: Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.

C. Fire Retardant Treated Wood: Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.

D. Fabricate woodwork to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:
   1. Corners of Cabinets and Edges of Solid-Wood (Lumber) Members ¾ in (19 mm) Thick or Less: 1/16 in (1.5 mm).
   2. Edges of Rails and Similar Members More Than ¾ in (19 mm) Thick: 1/8 in (3 mm).

E. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
   1. Notify Architect seven days in advance of the dates and times woodwork fabrication will be complete.
   2. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements indicated on Shop Drawings before disassembling for shipment.

F. Shop-cut openings to maximum extent possible to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
   1. Countertops: Seal edges of openings in countertops.

G. Install glass to comply with applicable requirements in DIVISION 08 SECTION "GLAZING" and in GANA's "Glazing Manual". For glass in wood frames, secure glass with removable stops.

H. Seal all wooden casework edges, including the wood that sits on the floor.

2.08 FLUSH PLASTIC-LAMINATE PANELING:

A. Grade: Custom.

B. Laminate Cladding for Exposed Surfaces: High-pressure decorative laminate complying with the following requirements:
   1. Faces: Grade HGS, 1.0 mm thick.
   2. Edges: Same as faces.

C. Concealed Backs of Panels with Exposed Plastic Laminate Surfaces: High-pressure decorative laminate, Grade BKH, 1.0 mm thick.

D. Fire-Retardant-Treated Paneling: Provide panels consisting of fire-retardant plastic laminate and veneer core plywood. Panels shall have a flame-spread rating of 75 or less and a smoke-developed rating of 450 or less per ASTM E 84.

2.09 PLASTIC-LAMINATE CABINETS:

A. Grade: Custom.

B. AWI Type of Cabinet Construction: Reveal overlay unless indicated otherwise.

C. Laminate Cladding for Exposed Surfaces: High-pressure decorative laminate complying with the following requirements:
   1. Horizontal Surfaces Other Than Tops: Grade HGP, .038 in (1 mm) thick.
   2. Postformed Surfaces: Grade HGP, .038 in (1 mm) thick.
   3. Doors and Vertical Surfaces: Grade VGS, .028 in (0.7 mm) thick.

4. Edges: PVC Edge Banding, 0.12 in (3 mm) thick, matching laminate in color, pattern, and finish.

D. Semi-exposed Surfaces: Provide surface materials indicated below:
1. Surfaces Other Than Drawer Bodies: High-pressure decorative laminate, Grade CLS, .020 in (0.5 mm) thick.
2. Edges: PVC Edge Banding, .038 in (1 mm) thick, matching laminate in color, pattern, and finish.
3. Drawer Sides, Backs and Sub-Fronts: 1/2 in (12 mm) minimum thickness, as indicated.
a. Solid-hardwood lumber.
4. Drawer Bottoms: 1/4 in (6 mm) minimum thickness, as indicated.
a. Hardwood plywood with veneer core.
5. Drawer Box Construction: One of the following:
a. Glued multiple dovetail.
b. Glued French dovetail.
c. Glued and doweled.
6. Interior Drawer Box Finish, as indicated:
a. Clear catalyzed polyurethane.

E. Body Members (Ends, Divisions, Bottoms and Sub-Tops): Plywood, 3/4 in (19 mm) minimum thickness.

F. Face Frames, Rails, Kicks and Bases: Solid-hardwood lumber or hardwood plywood, 3/4 in (19 mm) thick minimum thickness.

G. Shelves: Hardwood plywood core with veneer with the following thickness:
1. For Spans Up To 32 in (800 mm): 3/4 in (19 mm).
For Spans Up To 42 in (1050 mm): 1 in (25 mm).

H. Drawer Fronts: Plywood, 3/4 in (19 mm) thick minimum thickness.

I. Doors:
1. Hinged Flush Type: Medium density plywood with minimum thickness of 3/4 in (19 mm).
a. Maximum cabinet door size: 20 in (500 mm) width and 84 in (2100 mm) height.
b. For Doors Larger than Sizes Above: 1-3/8 in (35 mm) or 1-3/4 in (45 mm) doors; refer to DIVISION 08 SECTION "FLUSH WOOD DOORS".
c. If hinge screws enter only edge of door, provide 3/4 in (19 mm) lumber edges glued to core prior to laminating.
d. Edges: PVC Edge Banding, 0.12 in (3mm) thick, matching laminate in color, pattern and finish

J. Concealed Backs of Panels with Exposed Plastic Laminate Surfaces: High-pressure decorative laminate, Grade BKL, .020 in (0.5 mm) thick.

K. Concealed Edges of Base Cabinet Panels: Including but not limited to floors, vertical edges, splashes and countertops; Clear Catalyzed Polyurethane.

2.10 PLASTIC-LAMINATE COUNTERTOPS:

A. Grade: Custom.

B. High-Pressure Decorative Laminate Grade:
1. High-Pressure Decorative Laminate Grade for Flat Countertops: Grade HGS, .048 in (1.2 mm) thick.
2. High-Pressure Decorative Laminate Grade for Post-formed Countertops: Grade HGP, .038 in (1.0 mm) thick.

C. Grain Direction for Wood Grain Laminates: Parallel to cabinet fronts.

D. Edge Treatment: PVC edge banding, 0.12 in (3 mm) thick, matching laminate in color, pattern, and finish, as indicated.
E. Core Material for Countertops: Plywood, moisture resistant, binder containing no added urea formaldehyde, 3/4 in (19 mm) thick minimum thickness.
F. Core Material for Side and Back Splashes: Plywood, moisture resistant, binder containing no added urea formaldehyde, 1/2 in (12 mm) thick minimum thickness.
G. Backer Sheet: Provide plastic-laminate backer sheet, Grade BKL, .020 in (0.5 mm) thick, on underside of countertop substrate.
H. Concealed Backs and Edges at Side and Back Splashes: High-pressure decorative laminate, Grade BKL, .020 in (0.5 mm) thick.

2.11 SOLID SURFACE COUNTERTOPS:
A. Grade: Custom
B. Solid-Surfacing-Material Thickness: 1/2 inch (13mm)
C. Colors, Patterns, and Finishes: Provide materials and products that result in colors of solid surfacing material complying with the following requirements:
1. As selected by Architect from manufacturer's full range.
D. Fabricate tops in one piece, unless otherwise indicated. Comply with solid-surfacing-material manufacturer's written recommendations for adhesives, sealers, fabrication and finishing
1. Fabricate tops with shop-applied edges of materials and configuration indicated
2. Fabricate tops with integral shop-applied backsplashes and loose side-splashes for field Application.
E. Install integral sink bowls in countertops in shop.
1. Integral Bowl Manufacturers and Products:
a. Corian, Accessible 8254 at all multi-stall toilets, single-person toilets, lactation, respite and wellness, and patient toilets (U.N.O) rooms.
b. Corian, Neat 802P at all NSICU patient toilets and NICU patient rooms.
c. Approved Equal
2. Integral Bowl Color: Corian, Cameo White
F. Drill holes in countertops for plumbing fittings in shop.

PART 3 - EXECUTION

3.01 EXAMINATION:
A. Acceptance of Surfaces and Conditions: Examine substrates to receive interior architectural woodwork and associated work to which interior architectural woodwork will be applied for compliance with requirements and other conditions affecting performance. Proceed only when unsatisfactory conditions have been corrected in a manner complying with Contract Documents. Starting work within a particular area will be construed as acceptance of surface conditions.

3.02 INSTALLATION, GENERAL:
A. Installation Quality Standards: In addition to standards listed elsewhere, perform Work according to following, unless otherwise specified:
1. Quality standards. (The Contract Documents contain selections chosen from options in the quality standard and additional requirements beyond those of the quality standard. Comply with such selections and requirements in addition to the quality standard.)
2. Respective manufacturer/fabricator’s written installation instructions.

3. Accepted submittals.
4. Contract Documents.

3.03 PREPARATION:

A. General: Comply with manufacturer's instructions, recommendations, and specifications for cleaning and surface preparation. Surfaces shall have no defects, contaminants, or errors which would result in poor or potentially defective installation or would cause latent defects in Work.

B. Before installation, condition woodwork to average prevailing humidity conditions in installation areas.

C. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

3.04 INSTALLATION:

A. Assemble woodwork and complete fabrication at Project site to comply with requirements for fabrication, to extent that it was not completed in the shop.

B. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of 1/8 in per 96 in (3 mm per 2400 mm).

C. Scribe and cut woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

D. Fire-Retardant-Treated Wood: Handle, store, and install fire-retardant-treated wood to comply with chemical treatment manufacturer's written instructions, including those for adhesives used to install woodwork.

E. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated.

F. Paneling: Anchor paneling to supporting substrate with concealed panel-hanger clips. Do not use face fastening, unless covered by trim or otherwise indicated.
   1. Install flush paneling with no more than 1/16 in per 96 in (1.5 mm per 2400 mm) vertical cup or bow and 1/8 in per 96 in (3 mm per 2400 mm) horizontal variation from a true plane.
   2. Flush Paneling with Revealed Joints: Install with variations in reveal width, alignment of top and bottom edges, and flushness between adjacent panels not exceeding 1/32 in (0.75 mm).

G. Cabinets, General: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
   1. Install cabinets with no more than 1/8 in per 96 in (3 mm per 2400 mm) sag, bow, or other variation from a straight line.

H. Base and Wall Cabinets: Set base cabinets straight, level, and plumb. Adjust subtops within 1/16 in (1.5 mm) of a single plane. Fasten base cabinets to partition framing, or reinforcements in partitions with fasteners spaced 24 in (600 mm) on center. Bolt adjacent cabinets together with joints flush, tight, and uniform.
   1. Where base cabinets are not installed adjacent to walls, fasten to floor at toe space with fasteners spaced 24 in (600 mm) on center. Secure sides of cabinets to floor, where they do not adjoin other cabinets, with not less than two fasteners.

2. Wall Cabinets: Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 in (400 mm) on center with No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish or toggle bolts through metal backing or metal framing behind wall finish.

I. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.

1. Where possible make field jointing in the same manner as shop jointing, using dowels, splines, adhesives, and fasteners recommended by manufacturer. Prepare edges to be joined in shop so Project-site processing of top and edge surfaces is not required. Locate field joints where shown on Shop Drawings.
2. Plastic Laminate Countertops: Secure field joints in plastic-laminate countertops with concealed clamping devices located within 6 in (150 mm) of front and back edges and at intervals not exceeding 24 in (600 mm). Tighten according to manufacturer's written instructions to exert a constant, heavy-clamping pressure at joints.
3. Solid Surface Countertops: Align adjacent solid-surfacing-material countertop and form seam to comply with manufacturer's written recommendations using adhesive in color to match countertop.
4. Abut top and edge surfaces in one true plane, with internal supports placed to prevent deflection.
5. Install countertops with no more than 1/8 in per 96 in (3 mm per 2400 mm) sag, bow, or other variation from a straight line.
6. Secure backsplashes to tops with concealed metal brackets at 16 in (400 mm) on center and to walls with adhesive.
7. Calk space between backsplash and wall with sealant specified in DIVISION 07 SECTION "JOINT SEALANTS".

J. Touch up finishing work specified in this SECTION after installation of woodwork. Fill nail holes with matching filler where exposed.

3.05 ADJUSTING AND CLEANING:

A. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.

B. Clean, lubricate, and adjust hardware.

C. Clean woodwork on exposed and semi-exposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION 06 40 23

SECTION 07 72 00 – ROOF ACCESSORIES

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. Roof curbs.
   2. Equipment supports.
   3. Pipe and duct supports.
   4. Pipe portals.

1.03 RELATED REQUIREMENTS:

A. SECTION 05 50 00 "METAL FABRICATIONS" for metal vertical ladders, ships' ladders, and stairs for access to roof hatches.

B. SECTION 07 62 00 "SHEET METAL FLASHING AND TRIM" for shop- and field-formed metal flashing, roof-drainage systems, roof expansion-joint covers, and miscellaneous sheet metal trim and accessories.

C. SECTION 07 72 53 "SNOW GUARDS" for snow guards.

1.04 REFERENCED STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. ASTM International:
   1. ASTM A 123/A 123M - Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   2. ASTM A 153/A 153M - Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   3. ASTM A 500/A 500M - Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
   4. ASTM A 653/A 653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   5. ASTM A 780/A 780M - Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
   6. ASTM B 209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   7. ASTM B 209M - Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
   8. ASTM B 221 - Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
   9. ASTM B 221M - Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric).
   10. ASTM B 429/B 429M - Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
   11. ASTM C 726 - Specification for Mineral Wool Roof Insulation Board.
   12. ASTM C 920 - Specification for Elastomeric Joint Sealants.
   13. ASTM C 1289 - Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.

14. ASTM C 1311 - Specification for Solvent Release Sealants.
15. ASTM D 1187/D 1187M - Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal.
16. ASTM D 2244 - Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.
17. ASTM D 4214 - Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films.
18. ASTM F 2329/F 2329M - Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.

C. Code of Federal Regulations:
   1. 29 CFR, Subpart 1910.28 - Duty to Have Fall Protection and Falling Object Protection.

D. National Association of Architectural Metal Manufacturers:
   1. Metal Finishes Manual for Architectural and Metal Products.

1.05 COORDINATION:

A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.

B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1.06 SUBMITTALS:

A. Product Data: For each type of roof accessory.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For roof accessories.
   1. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.

C. Delegated-Design Submittal: For roof curbs and equipment supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Detail mounting, securing, and flashing of roof-mounted items to roof structure. Indicate coordinating requirements with roof membrane system.

D. Sample Warranties: For manufacturer's special warranties.

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

1.07 WARRANTY:

A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
      a. Color fading more than 5 Delta units when tested according to ASTM D2244.
      b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
      c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
   2. Finish Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. General Performance: Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

B. Delegated Design: Engage a qualified professional engineer to design roof curbs and equipment supports to comply with wind performance requirements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

C. Wind-Restraint Performance: As indicated on Drawings.

2.02 ROOF CURBS:

A. Roof Curbs: Internally reinforced roof-curb units capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings, bearing continuously on roof structure, and capable of meeting performance requirements; with welded or mechanically fastened and sealed corner joints, straight sides, and integrally formed deck-mounting flange at perimeter bottom.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AES Industries, Inc.
   b. Conn-Fab Sales, Inc.
   c. Greenheck Fan Corporation.
   d. Pate Company (The).
   e. Thybar Corporation.

B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.

C. Supported Load Capacity: Coordinate load capacity with information on Shop Drawings of equipment to be supported.

D. Material: Zinc-coated (galvanized) steel sheet, minimum 0.052 inch (1.32 mm) thick.

1. Finish: Mill phosphatized.

E. Construction:

1. Curb Profile: Manufacturer's standard compatible with roofing system.
2. Fabricate curbs to minimum height of 12 inches (305 mm) above roofing surface unless otherwise indicated.
3. Top Surface: Level top of curb, with roof slope accommodated by sloping deck-mounting flange or by use of leveler frame.
4. Insulation: Factory insulated with 1-1/2-inch- (38-mm-) thick glass-fiber board insulation.
5. Nailer: Factory-installed wood nailer along top flange of curb, continuous around curb perimeter.
6. Wind Restraint Straps and Base Flange Attachment: Provide wind restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb, of size and spacing required to meet wind uplift requirements.
7. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as curb.

2.03 EQUIPMENT SUPPORTS:

A. Equipment Supports: Internally reinforced perimeter and rail-type metal equipment supports capable of supporting superimposed live and dead loads between structural supports, including equipment loads and other construction indicated on Drawings, spanning between structural supports; capable of meeting performance requirements; with welded or mechanically fastened and sealed corner joints, and integrally formed structure-mounting flange at bottom.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. AES Industries, Inc.
      b. Conn-Fab Sales, Inc.
      c. Greenheck Fan Corporation.
      d. Pate Company (The).
      e. Thybar Corporation.

B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.

C. Supported Load Capacity: Coordinate load capacity with information on Shop Drawings of equipment to be supported.

D. Material: Zinc-coated (galvanized) steel sheet, minimum 0.064 inch (1.63 mm) thick.
   1. Finish: Mill phosphatized.

E. Construction:
   1. Curb Profile: Manufacturer's standard compatible with roofing system.
   2. Insulation: Factory insulated with 1-1/2-inch- (38-mm-) thick glass-fiber board insulation.
   3. Nailer: Factory-installed continuous wood nailers 3-1/2 inches (90 mm) wide on top flange of equipment supports, continuous around support perimeter.
   4. Wind Restraint Straps and Base Flange Attachment: Provide wind restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb of size and spacing required to meet wind uplift requirements.
   5. Platform Cap: Where portion of equipment support is not covered by equipment, provide weathertight platform cap formed from 3/4-inch- (19-mm-) thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.
   6. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as equipment support.
   7. Fabricate equipment supports to minimum height of 12 inches (305 mm) above roofing surface unless otherwise indicated.

2.04 PIPE AND DUCT SUPPORTS:

A. Fixed-Height Cradle-Type Pipe Supports: Polycarbonate pipe stand accommodating up to 1-1/2-inch diameter pipe or conduit; with provision for pipe retainer and with manufacturer's support pad or deck plate as recommended for penetration-free installation over roof membrane type; as required for quantity of pipe runs and sizes.
   1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
      a. MIRO Industries.
      b. Pate Company (The).

c. PHP Systems/Design.
d. Thaler Metal Industries Ltd.

2.05 PIPE PORTALS:

A. Flashing Pipe Portal: Formed aluminum membrane-mounting flashing flange and sleeve with collared opening and pressure-sealed conically shaped EPDM protective rubber cap sized for piping indicated, with stainless steel snaplock swivel clamps.
1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
a. Roof Products and Systems (RPS); a division of Hart & Cooley, Inc.

2.06 ROOF RAMPS:

A. Roof Ramp: Metal planking formed from multiple C-shaped channels with upper surface punched in serrated diamond or rectangular shapes to produce raised slip-resistant surface and drainage holes or metal grating with traction grip. Provide support framing, brackets, connectors, nosings, and other accessories and components needed for complete installation.
1. Comply with ASCE-7, 29 CFR 1910.28, and requirements of authorities having jurisdiction.
2. Equip ramps with safety railings.
3. Basis-of-Design Product: Subject to compliance with requirements, provide PHP Systems/Design; Roof Ramps or comparable product by one of the following:
a. B-line, an Eaton business.
b. MIRO Industries.
c. Rooftop Support Systems.
d. Unistrut; Part of Atkore International.
4. Plank Width: 12 inches (305 mm).
5. Ramp Width: As indicated on Drawings.
6. Channel Depth: 2 inches (50 mm).
7. Metal Material: Minimum 0.050-inch- (1.27-mm-) thick zinc-coated (galvanized) steel sheet.
8. Support Stands: Manufacturer's standard, with protective pads compatible with roofing material.
9. Wind Restraint: Provide wind restraint attachment to roof structure of size and spacing required to meet wind uplift requirements.
10. Finish: Manufacturer's standard.

2.07 METAL MATERIALS:

A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, G90 (Z275) coating designation and mill phosphatized for field painting where indicated.
1. Mill-Phosphatized Finish: Manufacturer's standard for field painting.
B. Aluminum Sheet: ASTM B209 (ASTM B209M), manufacturer's standard alloy for finish required, with temper to suit forming operations and performance required.
1. Mill Finish: As manufactured.
C. Aluminum Extrusions and Tubes: ASTM B221 (ASTM B221M), manufacturer's standard alloy and temper for type of use, finished to match assembly where used; otherwise mill finished.

D. Aluminum Pipe: ASTM B429/B429M, schedule 40 pipe.
E. Steel Tube: ASTM A500/A500M, round tube.
F. Galvanized-Steel Tube: ASTM A500/A500M, round tube, hot-dip galvanized according to ASTM A123/A123M.

2.08 MISCELLANEOUS MATERIALS:

A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.
B. Glass-Fiber Board Insulation: ASTM C726, nominal density of 3 lb/cu. ft. (48 kg/cu. m), thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F (29.8 K x m/W at 24 deg C), thickness as indicated.
C. Polyisocyanurate Board Insulation: ASTM C1289, thickness and thermal resistivity as indicated.
D. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWPA C2; not less than 1-1/2 inches (38 mm) thick.
E. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
F. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:
    1. Fasteners for Zinc-Coated or Aluminum-Zinc Alloy-Coated Steel: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A153/A153M or ASTM F2329/F2329M.
    2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
G. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.
H. Elastomeric Sealant: ASTM C920, elastomeric siliconepolymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.
I. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.

2.09 GENERAL FINISH REQUIREMENTS:

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

PART 3 - EXECUTION

3.01 EXAMINATION:

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

3.02 INSTALLATION:

A. General: Install roof accessories according to manufacturer's written instructions.
   1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
   2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
   3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
   4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
   1. Coat concealed side of uncoated aluminum roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
   2. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of underlayment and cover with manufacturer's recommended slip sheet.

C. Roof Curb Installation: Install each roof curb so top surface is level.

D. Equipment Support Installation: Install equipment supports so top surfaces are level with each other.

E. Roof-Hatch Installation:
   1. Verify that roof hatch operates properly. Clean, lubricate, and adjust operating mechanism and hardware.
   2. Attach safety railing system to roof-hatch curb.

F. Seal joints with elastomeric or butylsealant as required by roof accessory manufacturer.

3.03 REPAIR AND CLEANING:

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A780/A780M.

B. Clean exposed surfaces according to manufacturer's written instructions.

C. Clean off excess sealants.

D. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 07 72 00

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SECTION 07 84 13 - PENETRATION FIRESTOPPING

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. Penetration firestopping systems for the following applications:
      a. Penetrations in fire-resistance-rated walls.
      b. Penetrations in horizontal assemblies.
      c. Penetrations in smoke barriers.

B. Related Requirements:

1.03 PREINSTALLATION MEETINGS:

A. Preinstallation Conference: Conduct conference at Project site.

1.04 ACTION SUBMITTALS:

A. Product Data: For each type of product.

B. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.
   1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly. Obtain approval of authorities having jurisdiction prior to submittal.

1.05 INFORMATIONAL SUBMITTALS:

A. Qualification Data: For Installer.

B. Product Test Reports: For each penetration firestopping system, for tests performed by a qualified testing agency.

1.06 CLOSEOUT SUBMITTALS:

A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.07 QUALITY ASSURANCE:

A. Installer Qualifications: A firm that has been approved by FM Approval according to FM Approval 4991, "Approval Standard for Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."
   1. Installation personnel shall have a minimum of 3 years of experience in firestop installations.

1.08 PROJECT CONDITIONS:

A. 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.

B. Install and cure penetration firestopping materials per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.09 COORDINATION:

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping systems can be installed according to specified firestopping system design.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping systems.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. Fire-Test-Response Characteristics:

1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test per testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:
   a. Penetration firestopping systems shall bear classification marking of a qualified testing agency.
      1) UL in its "Fire Resistance Directory."
      2) Intertek Group in its "Directory of Listed Building Products."
      3) FM Approval in its "Approval Guide."

2.02 PENETRATION FIRESTOPPING SYSTEMS:

A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Hilti, Inc. ; CFS-DID or a comparable product by one of the following:
   a. 3M Fire Protection Products.
   b. Specified Technologies, Inc.

B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).

1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E814 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.

D. 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.

E. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, per ASTM E84.

F. Manufactured Piping Penetration Firestopping System: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Hilti, Inc. or comparable product by one of the following:
      a. 3M Fire Protection Products.
      b. Specified Technologies, Inc.
   2. F-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated.
   3. 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.
   4. W-Rating: Provide penetration firestopping systems showing no evidence of water leakage when tested according to UL 1479.
   5. Sleeve: Molded-PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
   6. Stack Fitting: ASTM A48/A48M, gray-iron, hubless-pattern wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
   7. Special Coating: Corrosion resistant on interior of fittings.

G. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.
   1. Permanent forming/damming/backing materials.
   2. Substrate primers.
   3. Collars.
   4. Steel sleeves.

2.03 FILL MATERIALS:

A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer sleeve lined with an intumescent strip, a flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.

C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced intumescent elastomeric sheet bonded to galvanized-steel sheet.

E. Intumescent Putties: Nonhardening, water-resistant, intumescent putties containing no solvents or inorganic fibers.
F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.
I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants.

2.04 MIXING:

A. Penetration Firestopping Materials: 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.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:

A. 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.
B. 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.

3.03 INSTALLATION:

A. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.

B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.
   1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.

C. 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.

3.04 IDENTIFICATION:

A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches (76 mm) high and with minimum 0.375-inch (9.5-mm) strokes.
   1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet (4.57 m) from end of wall and at intervals not exceeding 30 feet (9.14 m).

B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
   1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
   2. Contractor's name, address, and phone number.
   3. Designation of applicable testing and inspecting agency.
   4. Date of installation.
   5. Manufacturer's name.
   6. Installer's name.

3.05 FIELD QUALITY CONTROL:

A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E2174.
   1. Firestop inspections as required by IBC Chapter 17.
   2. Where IBC Chapter 17 special inspections requirements do not apply, all firestop system inspections will be performed by Campus or 3rd party building inspectors, as required.

B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.

C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.06 CLEANING AND PROTECTION:

A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping system manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping 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.

END OF SECTION 07 84 13

SECTION 07 84 43 - JOINT FIRESTOPPING

PART 1 - GENERAL

1.01 SUMMARY:

A. SECTION Includes:
   1. Joints in or between fire-resistance-rated constructions.
   2. Joints at exterior curtain-wall/floor intersections.
   3. Joints in smoke barriers.

B. Related Requirements:
   1. SECTION 07 84 13 "PENETRATION FIRESTOPPING" for penetrations in fire-resistance-rated walls, horizontal assemblies, and smoke barriers.
   2. SECTION 07 95 13.13 "INTERIOR EXPANSION JOINT COVER ASSEMBLIES" for fire-resistive manufactured expansion-joint cover assemblies for interior floors, walls, and ceilings.
   3. SECTION 07 95 13.16 "EXTERIOR EXPANSION JOINT COVER ASSEMBLIES" for fire-resistive manufactured expansion-joint cover assemblies for exterior building walls, soffits, and parapets.
   4. SECTION 09 22 16 "NON-STRUCTURAL METAL FRAMING" for firestop tracks for metal-framed partition heads.

1.02 PREINSTALLATION MEETINGS:

A. Preinstallation Conference: Conduct conference at Project site.

1.03 ACTION SUBMITTALS:

A. Product Data: For each type of product.

B. Product Schedule: For each joint firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing agency.
   1. Engineering Judgments: Where Project conditions require modification to a qualified testing agency's illustration for a particular joint firestopping system condition, submit illustration, with modifications marked, approved by joint firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly developed in accordance with current International Firestop Council (IFC) guidelines.

1.04 INFORMATIONAL SUBMITTALS:

A. Qualification Data: For Installer.

B. Listed System Designs: For each joint firestopping system, for tests performed by a qualified testing agency.

1.05 CLOSEOUT SUBMITTALS:

A. Installer Certificates: From Installer indicating that joint firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.06 QUALITY ASSURANCE:

A. Installer Qualifications: A firm that has been approved by FM Approvals according to FM Approvals 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with UL's "Qualified Firestop Contractor Program Requirements."

1. Installation personnel shall have a minimum of 3 years of experience in firestop installations.

1.07 PROJECT CONDITIONS:

A. Environmental Limitations: Do not install joint firestopping systems when ambient or substrate temperatures are outside limits permitted by joint firestopping system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Install and cure joint firestopping systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

1.08 COORDINATION:

A. Coordinate construction of joints to ensure that joint firestopping systems can be installed according to specified firestopping system design.

B. Coordinate sizing of joints to accommodate joint firestopping systems.

PART 2 - PRODUCTS

2.01 SOURCE LIMITATIONS:

A. Obtain joint firestop systems for each type of joint opening indicated from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS:

A. Fire-Test-Response Characteristics:

1. Perform joint firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test per testing standards referenced in "Joint Firestopping Systems" Article. Provide rated systems complying with the following requirements:
    a. Joint firestop systems installed with products bearing the classification marking of a qualified product certification agency in accordance with Listed System Designs published by a qualified testing agency.
        1) UL in its online directory "Product iQ."
        2) Intertek Group in its "Directory of Building Products."

B. Rain/Water Resistance: For perimeter fire-barrier system applications, where inclement weather or greater-than-transient water exposure is expected, use products that dry rapidly and cure in the presence of atmospheric moisture sufficient to pass ASTM D6904 early rain-resistance test (24-hour exposure).

2.03 JOINT FIRESTOPPING SYSTEMS:

A. Joint Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which joint firestopping systems are installed. Joint firestopping systems must accommodate building movements without impairing their ability to resist the passage of fire and hot gases.

1. Joint firestopping systems that are compatible with one another, with the substrates forming openings, and with penetrating items, if any.
2. Provide products that, upon curing, do not re-emulsify, dissolve, leach, breakdown, or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture.

3. Provide firestop products that do not contain ethylene glycol.

B. For aluminum curtain-wall assemblies with one- or two-piece rectangular mullions at least 2-1/2 by 5 inches (64 by 127 mm), provide perimeter fire-barrier system that does not require direct screw attachment to mullions and transoms to support and fasten curtain-wall insulation. System to be tested in accordance with ASTM E2307 for up to 2-hour fire resistance and with ASTM E1233 for wind cycling equivalent to 108 mph (174 km/h) wind for 500 cycles.

C. Joints in or between Fire-Resistance-Rated Construction: Provide joint firestopping systems with ratings determined per ASTM E1966 or UL 2079.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Hilti, Inc. or a comparable product by one of the following:
   a. 3M Fire Protection Products.
   b. Specified Technologies, Inc.
2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the wall, floor, or roof in or between which it is installed.

D. Joints at Exterior Curtain-Wall/Floor Intersections: Provide joint firestopping systems with rating determined per ASTM E2307.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Hilti, Inc. or a comparable product by one of the following:
   a. 3M Fire Protection Products.
   b. Specified Technologies, Inc.
2. F-Rating: Equal to or exceeding the fire-resistance rating of the floor assembly.

E. Joints in Smoke Barriers: Provide joint firestopping systems with ratings determined per UL 2079 based on testing at a positive pressure differential of 0.30-inch wg (74.7 Pa).
1. Basis-of-Design Product: Subject to compliance with requirements, provide Hilti, Inc. or a comparable product by one of the following:
   a. 3M Fire Protection Products.
   b. Specified Technologies, Inc.
2. L-Rating: Not exceeding 5.0 cfm/ft. (0.00775 cu. m/s x m) of joint at both ambient and elevated temperatures.

F. Exposed Joint Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E84.

2.04 ACCESSORIES:

A. Provide components of joint firestopping systems, including primers and forming materials, that are needed to install elastomeric fill materials and to maintain ratings required. Use only components specified by joint firestopping system manufacturer and approved by the qualified testing agency for conditions indicated.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:

A. Surface Cleaning: Before installing joint firestopping systems, clean joints immediately to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:
   1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of elastomeric fill materials or compromise fire-resistive rating.
   2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with elastomeric fill materials. Remove loose particles remaining from cleaning operation.
   3. Remove laitance and form-release agents from concrete.

B. Prime substrates where recommended in writing by joint firestopping system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Apply a suitable bond-breaker to prevent three-sided adhesion in applications where this condition occurs, such as the intersection of a gypsum wall to floor or roof assembly where the joint is backed by a steel ceiling runner or track.

3.03 INSTALLATION:

A. General: Install joint firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support elastomeric fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
   1. After installing elastomeric fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.

C. Install elastomeric fill materials for joint firestopping systems by proven techniques to produce the following results:
   1. Elastomeric fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
   2. Apply elastomeric fill materials so they contact and adhere to substrates formed by joints.
   3. For elastomeric fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.04 IDENTIFICATION:

A. Wall Identification: Permanently label walls containing firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches (76 mm) high and with minimum 0.375-inch (9.5-mm) strokes.
   1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 ft. (4.57 m) from end of wall and at intervals not exceeding 30 ft. (9.14 m).

B. Joint Identification: Identify joint firestopping systems with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of joint edge so labels are visible to anyone seeking to remove or joint firestopping system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
   1. The words "Warning - Joint Firestopping - Do Not Disturb. Notify Building Management of Any Damage."

2. Contractor's name, address, and phone number.
3. Designation of applicable testing agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.05 FIELD QUALITY CONTROL:

A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E2393.
   1. Firestop inspections as required by IBC Chapter 17.
   2. Where IBC Chapter 17 special inspections requirements do not apply, all firestop system inspections will be performed by Campus or 3rd party building inspectors, as required.

B. Where deficiencies are found or joint firestopping systems are damaged or removed due to testing, repair or replace joint firestopping systems so they comply with requirements.

C. Proceed with enclosing joint firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.06 CLEANING AND PROTECTION:

A. Clean off excess elastomeric fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by joint firestopping system manufacturers and that do not damage materials in which joints occur.

B. Provide final protection and maintain conditions during and after installation that ensure joint firestopping systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated joint firestopping systems immediately and install new materials to produce joint firestopping systems complying with specified requirements.

3.07 JOINT FIRESTOPPING SYSTEM SCHEDULE:

A. Where UL-classified systems are indicated, they refer to system numbers in UL's online directory "Product iQ" under product [**Category XHBN**] [**or**] [**Category XHDG**].

B. Where Intertek Group-listed systems are indicated, they refer to design numbers in Intertek Group's "Directory of Building Products" under product category **Firestop Systems**.

C. Perimeter Joint Firestopping Systems at Curtain Wall Spandrel Condition:
   1. UL-Classified Perimeter Fire-Containment Systems: CW-**D-1014**.
   2. Linear Opening Width: **4 inches (101.6 mm)**, maximum.
   3. Movement Capabilities: **Class II**.
   4. F-Rating: **2 hours**.

D. Perimeter Joint Firestopping Systems at Curtain Wall Zero Spandrel Condition:
   1. Intertek Group-Listed, Perimeter Fire-Barrier Systems, provide one of the following:
      a. Hilti Firestop Systems; Design No. HI/BPF 120-10.
      b. Specified Technologies, Inc.; Design No. STI/BPF 120-03.
   2. F-Rating: 2 hours.

END OF SECTION 07 84 43

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SECTION 07 92 19 – ACOUSTICAL JOINT SEALANTS

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 acoustical joint sealants.

1.03 RELATED REQUIREMENTS:

A. SECTION 07 92 00 "JOINT SEALANTS" for elastomeric, latex, and butyl-rubber-based joint sealants for Non acoustical applications.

1.04 REFERENCED STANDARDS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. ASTM International

1. ASTM C 834 - Specification for Latex Sealants.
2. ASTM C 919 - Practice for Use of Sealants in Acoustical Applications.
3. ASTM C 1193 - Guide for Use of Joint Sealants.
4. ASTM E 90 - Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

1.05 SUBMITTALS:

A. Product Data: For each acoustical joint sealant.

B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Samples for Verification: For each kind and color of acoustical joint sealant required, provide Samples with joint sealants in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

D. Acoustical-Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

E. Product Test Reports: For each kind of acoustical joint sealant, for tests performed by manufacturer and witnessed by a qualified testing agency or a qualified testing agency.

F. Sample Warranties: For special warranties.

1.06 WARRANTY:

A. Special Installer's Warranty: Installer agrees to repair or replace acoustical joint sealants that do not comply with performance and other requirements specified in this SECTION within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish acoustical joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this SECTION within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. Provide acoustical joint-sealant products that effectively reduce airborne sound transmission through perimeter joints and openings in building construction, as demonstrated by testing representative assemblies according to ASTM E90.

B. VOC Content: Sealants and sealant primers shall comply with the following:
   1. Architectural sealants shall have a VOC content of 250 g/L or less.
   2. Sealants and sealant primers for nonporous substrates shall have a VOC content of 250 g/L or less.
   3. Sealants and sealant primers for porous substrates shall have a VOC content of 775 g/L or less.

2.02 ACOUSTICAL JOINT SEALANTS:

A. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex acoustical sealant complying with ASTM C834.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. GE Construction Sealants; Momentive Performance Materials Inc.
      b. Grabber Construction Products.
      c. Hilti, Inc.
      d. Pecora Corporation.
      e. Tremco Incorporated.
      f. USG Corporation.
   2. Colors of Exposed Acoustical Joint Sealants: As selected by Architect from manufacturer's full range of colors.

2.03 MISCELLANEOUS MATERIALS:

A. Primer: Material recommended by acoustical-joint-sealant manufacturer where required for adhesion of sealant to joint substrates.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine joints indicated to receive acoustical joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:

A. Surface Cleaning of Joints: Clean out joints immediately before installing acoustical joint sealants to comply with joint-sealant manufacturer's written instructions.

B. Joint Priming: Prime joint substrates where recommended by acoustical-joint-sealant manufacturer. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.03 INSTALLATION OF ACOUSTICAL JOINT SEALANTS:

A. Comply with acoustical joint-sealant manufacturer's written installation instructions unless more stringent requirements apply.

B. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical joint sealant. Install acoustical joint sealants at both faces of partitions, at perimeters, and through penetrations. Comply with ASTM C919, ASTM C1193, and manufacturer's written recommendations for closing off sound-flanking paths around or through assemblies, including sealing partitions to underside of floor slabs above acoustical ceilings.

3.04 CLEANING:

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

3.05 PROTECTION:

A. Protect acoustical joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated acoustical joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION 07 92 19

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SECTION 07 95 13.13 - INTERIOR EXPANSION JOINT COVER ASSEMBLIES

PART 1 - GENERAL

1.01 SUMMARY:

A. SECTION includes interior expansion joint cover assemblies.

1.02 ACTION SUBMITTALS:

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for expansion joint cover assemblies.

B. Shop Drawings: For each expansion joint cover assembly.
   1. Include plans, elevations, sections, details, splices, block-out requirement, attachments to other work, and line diagrams showing entire route of each expansion joint.
   2. Where expansion joint cover assemblies change planes, provide isometric or clearly detailed drawing depicting how components interconnect.

C. Samples: For each expansion joint cover assembly and for each color and texture specified, full width by 6 inches (150 mm) long in size.

D. Samples for Initial Selection: For each type of exposed finish.
   1. Include manufacturer's color charts showing the full range of colors and finishes available for each exposed metal and elastomeric-seal material.

E. Samples for Verification: For each type of expansion joint cover assembly, full width by 6 inches (150 mm) long in size.

F. Expansion Joint Cover Assembly Schedule: Prepared by or under the supervision of the supplier. Include the following information in tabular form:
   1. Manufacturer and model number for each expansion joint cover assembly.
   2. Expansion joint cover assembly location cross-referenced to Drawings.
   3. Nominal, minimum, and maximum joint width.
   4. Movement direction.
   5. Materials, colors, and finishes.
   6. Product options.
   7. Fire-resistance ratings.

1.03 INFORMATIONAL SUBMITTALS:

A. Product Test Reports: For each fire-resistance-rated expansion joint cover assembly, for tests performed by manufacturer and witnessed by a qualified testing agency or a qualified testing agency.

PART 2 - PRODUCTS

2.01 ASSEMBLY DESCRIPTION:

A. Furnish units in longest practicable lengths to minimize field splicing.

B. Include factory-fabricated closure materials and transition pieces, T-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous expansion joint cover assemblies.

2.02 PERFORMANCE REQUIREMENTS:

A. Seismic Performance: Expansion joint cover assemblies to withstand the effects of earthquake motions determined according to ASCE/SEI 7.

B. Fire-Resistance Ratings: Provide expansion joint cover assemblies with fire barriers identical to those of systems tested for fire resistance according to UL 2079 or ASTM E1966 by a qualified testing agency.
   1. Hose Stream Test: Wall-to-wall and wall-to-ceiling assemblies to be subjected to hose stream testing.

C. Expansion Joint Design Criteria:
   1. Type of Movement: Wind and/or Seismic.
      a. Nominal Joint Width: As indicated on Drawings.
      b. Minimum Joint Width: 50 percent of the joint width.
      c. Maximum Joint Width: 150 percent of the joint width.

2.03 FLOOR EXPANSION JOINT COVERS:

A. Dual-Elastomeric-Seal Floor Joint Cover Type 8: Assembly consisting of dual-elastomeric seals and center plate anchored to frames fixed to sides of joint gap.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Construction Specialties, Inc.; model SGR-1000HD with Fire Barier or a comparable product by one of the following:
      a. Balco; a CSW Industrials Company.
      b. Inpro Corporation.
      c. Nystrom.
   2. Application: Floor to floor.
   3. Installation: Recessed.
   4. Load Capacity: Heavy Duty
      a. 2000 lb point load minumum.
   5. Fire-Resistance Rating: Not less than 2 hours.
   6. Center-Plate Design: Recessed to accept field-applied finish materials.
      a. Center-Plate Recess Depth: As required to accommodate adjacent flooring.
   7. Exposed Metal:
      a. Aluminum: Clear anodic, Class II.
   8. Seal: Preformed elastomeric membranes or extrusions.
      a. Color: As selected by Architect from manufacturer's full range.

2.04 WALL EXPANSION JOINT COVERS:

A. Dual-Elastomeric-Seal Wall Joint Cover Type 13: Assembly consisting of dual-elastomeric seals and center plate anchored to frames fixed to sides of joint gap.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Construction Specialties, Inc.; model SGW-1000 with fire barrier or a comparable product by one of the following:
      a. Balco; a CSW Industrials Company.
      b. Inpro Corporation.
      c. Nystrom.
   2. Application: Wall to wall.
   3. Center-Plate Design: Plain.
   4. Exposed Metal:
      a. Aluminum: Clear anodic, Class II.
   5. Seal: Preformed elastomeric membranes or extrusions.
      a. Color: As selected by Architect from manufacturer's full range.

2.05 CEILING EXPANSION JOINT COVERS:

A. Elastomeric-Seal Ceiling Joint Cover Type 5: Assembly consisting of elastomeric seal anchored to frames fixed to sides of joint gap.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Construction Specialties, Inc.; model FCF-1000 or a comparable product by one of the following:
      a. Balco; a CSW Industrials Company.
      b. Inpro Corporation.
      c. Nystrom.
   2. Application: Ceiling to ceiling.
   3. Aluminum: Mill finish (no finish)
   4. Seal: Preformed elastomeric membranes or extrusions.
      a. Color: As selected by Architect from manufacturer's full range.

B. Schedule of Expansion Joints

Type	Condition / Description	Basis of Design Model #
Type 5	10” Ceiling-to-Ceiling, Non-rated	FCF-1000
Type 8	10” Floor-to-Floor, 2-hr Rated, Heavy Duty	SGR-1000HD w/ FB
Type 13	10” Wall-to-Wall, 2 hr rated	SGW-1000 w/FB

2.06 MATERIALS:

A. Aluminum: ASTM B221 (ASTM B221M), Alloy 6063-T5 for extrusions; ASTM B209 (ASTM B209M), Alloy 6061-T6 for sheet and plate.
   1. Apply manufacturer's standard protective coating on aluminum surfaces to be placed in contact with cementitious materials.

B. Elastomeric Seals: Manufacturer's standard preformed elastomeric membranes or extrusions to be installed in metal frames.

C. Fire Barriers: Any material or material combination, when fire tested after cycling, designated to resist the passage of flame and hot gases through a movement joint and to comply with performance criteria for required fire-resistance rating.

D. Moisture Barrier: Manufacturer's standard, flexible elastomeric material.

E. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

2.07 ALUMINUM FINISHES:

A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

2.08 ACCESSORIES:

A. Moisture Barriers: Manufacturer's standard continuous, waterproof membrane within joint and attached to substrate on sides of joint.
   1. Provide where indicated on Drawings.

B. Manufacturer's standard attachment devices. Include anchors, clips, fasteners, set screws, spacers, and other accessories compatible with material in contact, as indicated or required for complete installations.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine surfaces where expansion joint cover assemblies will be installed for installation tolerances and other conditions affecting performance of the Work.

B. Notify Architect where discrepancies occur that will affect proper expansion joint cover assembly installation and performance.

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

3.02 PREPARATION:

A. Prepare substrates according to expansion joint cover assembly manufacturer's written instructions.

B. Coordinate and furnish anchorages, setting drawings, and instructions for installing expansion joint cover assemblies. Provide fasteners of metal, type, and size to suit type of construction indicated and to provide for secure attachment of expansion joint cover assemblies.

3.03 INSTALLATION:

A. Comply with manufacturer's written instructions for storing, handling, and installing expansion joint cover assemblies and materials unless more stringent requirements are indicated.

B. Metal Frames: Perform cutting, drilling, and fitting required to install expansion joint cover assemblies.

1. Repair or grout block out as required for continuous frame support using nonmetallic, shrinkage-resistant grout.
2. Install frames in continuous contact with adjacent surfaces.
   a. Shimming is not permitted.
3. Install in true alignment and proper relationship to joints and adjoining finished surfaces measured from established lines and levels.
4. Adjust for differences between actual structural gap and nominal design gap due to ambient temperature at time of installation.
5. Cut and fit ends to accommodate thermal expansion and contraction of metal without buckling of frames.
6. Locate anchors at interval recommended by manufacturer, but not less than 3 inches (75 mm) from each end and not more than 24 inches (600 mm) o.c.

C. Seals: Install elastomeric seals and membranes in frames to comply with manufacturer's written instructions. Install with minimum number of end joints.

1. Provide in continuous lengths for straight sections.
2. Seal transitions. Vulcanize or heat-weld field-spliced joints as recommended by manufacturer.
3. Installation: Mechanically lock seals into frames or adhere to frames with adhesive or pressure-sensitive tape as recommended by manufacturer.

D. Install with hairline mitered corners where expansion joint cover assemblies change direction or abut other materials.

E. Terminate exposed ends of expansion joint cover assemblies with field- or factory-fabricated termination devices.

F. Fire-Resistance-Rated Assemblies: Coordinate installation of expansion joint cover assembly materials and associated work so complete assemblies comply with performance requirements.

1. Fire Barriers: Install fire barriers to provide continuous, uninterrupted fire resistance throughout length of joint, including transitions and field splices.

G. Moisture Barrier Drainage: If indicated, provide drainage fittings and connect to drains.

3.04 PROTECTION:

A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's written instructions.

B. Protect the installation from damage by work of other Sections. Where necessary due to heavy construction traffic, remove and properly store cover plates or seals and install temporary protection over expansion joint cover assemblies. Reinstall cover plates or seals prior to Substantial Completion.

END OF SECTION 07 95 13.13

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SECTION 08 11 13 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.01 SUMMARY:

A. SECTION includes:
   1. Interior standard steel doors and frames.
   2. Exterior standard steel doors and frames.

B. Related Requirements:
   1. SECTION 08 71 11 "DOOR HARDWARE (DESCRIPTIVE SPECIFICATION)" for door hardware for hollow-metal doors.

1.02 DEFINITIONS:

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

1.03 COORDINATION:

A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

1.04 PREINSTALLATION MEETINGS:

A. Preinstallation Conference: Conduct conference at Project site.

1.05 ACTION SUBMITTALS:

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, core descriptions, fire-resistance ratings, and finishes.

B. Shop Drawings: Include the following:
   1. Elevations of each door type.
   2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
   3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
   4. Locations of reinforcement and preparations for hardware.
   5. Details of each different wall opening condition.
   6. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
   7. Details of anchorages, joints, field splices, and connections.
   8. Details of accessories.
   9. Details of moldings, removable stops, and glazing.

C. Samples for Initial Selection: For hollow-metal doors and frames with factory-applied color finishes.

D. Samples for Verification:
   1. Finishes: For each type of exposed finish required, prepared on Samples of not less than 3 by 5 inches (75 by 127 mm).

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

1.06 INFORMATIONAL SUBMITTALS:

A. Qualification Data: For door inspector.
   1. Submit copy of DHI Fire and Egress Door Assembly Inspector (FDAI) certificate.
B. Product Test Reports: For each type of fire-rated hollow-metal door and frame assembly for tests performed by a qualified testing agency indicating compliance with performance requirements.
C. Oversize Construction Certification: For assemblies required to be fire-rated and exceeding limitations of labeled assemblies.
D. Field quality control reports.

1.07 CLOSEOUT SUBMITTALS:

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

1.08 QUALITY ASSURANCE:

A. Fire-Rated Door Inspector Qualifications: Inspector for field quality control inspections of fire-rated door assemblies is to meet the qualifications set forth in NFPA 80, section 5.2.3.1 and the following:
   1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.
B. Egress Door Inspector Qualifications: Inspector for field quality control inspections of egress door assemblies is to meet the qualifications set forth in NFPA 101, Section 7.2.1.15.4 and the following:
   1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

1.09 DELIVERY, STORAGE, AND HANDLING:

A. Deliver hollow-metal doors and frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use non-vented plastic.
   1. Provide additional protection to prevent damage to factory-finished units.
B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
C. Store hollow-metal doors and frames vertically under cover at Project site with head up. Place on minimum 4-inch- (102-mm-) high wood blocking. Provide minimum 1/4-inch (6-mm) space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ceco Door; ASSA ABLOY.
   2. Curries Company; ASSA ABLOY.
   3. Pioneer Industries.

4. Republic Doors and Frames.
5. Steelcraft; an Allegion brand.

2.02 PERFORMANCE REQUIREMENTS:

A. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated on Drawings, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.
   1. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing in accordance with UL 1784 and installed in compliance with NFPA 105.
   2. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.

B. Fire-Rated, Borrowed-Lite Assemblies: Assemblies complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing in accordance with NFPA 257 or UL 9.

C. Thermally Rated Door Assemblies: Provide door assemblies with U-factor of not more than 0.38 deg Btu/F x h x sq. ft. (2.16 W/K x sq. m) when tested in accordance with ASTM C1363 or ASTM E1423.

2.03 INTERIOR STANDARD STEEL DOORS AND FRAMES:

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

B. Extra-Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 3; ANSI/SDI A250.4, Level A..
   1. Doors:
      a. Type: As indicated in the Door and Frame Schedule.
      b. Thickness: 1-3/4 inches (44.5 mm).
      c. Face: Uncoated steel sheet, minimum thickness of 0.053 inch (1.3 mm). 16 gauge minimum.
      d. Edge Construction: Model 2, Seamless.
      e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
      f. Core: Manufacturer's standard.
      g. Fire-Rated Core: Manufacturer's standard core for fire-rated doors.
      h. SDI Level 3 minimum fully welded.
   2. Frames:
      a. Materials: Uncoated steel sheet, minimum thickness of 0.053 inch (1.3 mm). 16 gauge minimum.
      b. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.
      c. Construction: Full profile welded. Ground and dress smooth.
      d. Frames for rated doors shall be securely anchored and grouted in plumb and level.
   3. Exposed Finish: Prime.

2.04 EXTERIOR STANDARD STEEL DOORS AND FRAMES:

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

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

1. Doors:
   a. Type: As indicated in the Door and Frame Schedule.
   b. Thickness: 1-3/4 inches (44.5 mm).
   c. Face: Metallic-coated steel sheet, minimum thickness of 0.053 inch (1.3 mm), with minimum A60 (ZF180) coating. 16 gauge minimum.
   d. Edge Construction: Model 2, Seamless.
   e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
   f. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
   g. Bottom Edges: Close bottom edges of doors with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
   h. Core: Polyurethane.
   i. Fire-Rated Core: Manufacturer's standard core for fire-rated doors.
   j. SDI Level 3 minimum fully welded.
2. Frames:
   a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch (1.3 mm), with minimum A60 (ZF180) coating. 14 gauge minimum.
   b. Construction: Face welded. Ground and dress smooth.
3. Exposed Finish: Prime.

2.05 BORROWED LITES:

A. Fabricate of uncoated steel sheet, minimum thickness of 0.042 inch (1.0 mm). 16 gauge minimum.

B. Construction: Face welded. Ground and dress smooth.

C. Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as metal as frames.

D. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

2.06 FRAME ANCHORS:

A. Jamb Anchors:

1. Stud-Wall Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:
   a. Three anchors per jamb up to 60 inches (1524 mm) high.
   b. Four anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
   c. Five anchors per jamb from 90 to 96 inches (2286 to 2438 mm) high.
   d. Five anchors per jamb plus one additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 96 inches (2438 mm) high.

2. Postinstalled Expansion Anchor: Minimum 3/8-inch- (9.5-mm-) diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.

B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.

C. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than 2-inch (51-mm) height adjustment. Terminate bottom of frames at top of underlayment.

D. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z (12G) coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized in accordance with ASTM A153/A153M, Class B.

2.07 MATERIALS:

A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.

D. Inserts, Bolts, and Fasteners: Hot-dip galvanized in accordance with ASTM A153/A153M.

E. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.

F. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.

G. Glazing: Comply with requirements in SECTION 08 80 00 "GLAZING."

H. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.08 FABRICATION:

A. Door Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch (19 mm) beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.

B. Hollow-Metal Doors:

1. Steel-Stiffened Door Cores: Provide minimum thickness 0.026 inch (0.66 mm), steel vertical stiffeners of same material as face sheets extending full-door height, with vertical webs spaced not more than 6 inches (152 mm) apart. Spot weld to face sheets no more than 5 inches (127 mm) o.c. Fill spaces between stiffeners with glass- or mineral-fiber insulation.

2. Fire Door Cores: As required to provide fire-protection ratings indicated.

C. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.

1. Sidelite and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding.
2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
3. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
   a. Form grout guards from same material as frames, not less than 0.016 inch (0.4 mm) thick.
4. Floor Anchors: Weld anchors to bottoms of jambs with at least four spot welds per anchor; however, for slip-on drywall frames, provide anchor clips or countersunk holes at bottoms of jambs.
5. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
   a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
   b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

D. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping in accordance with ANSI/SDI A250.6, the Door Hardware Schedule, and templates.
   1. Reinforce doors and frames to receive non-templated, mortised, and surface-mounted door hardware.
   2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.

E. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with ~~*[butted] [or] [*~~**mitered**~~*]*~~ hairline joints.
   1. Provide stops and moldings flush with face of door, and with ~~*[beveled] [*~~**square**~~*]*~~ stops unless otherwise indicated.
   2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
   3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames. Provide loose stops and moldings on inside of hollow-metal doors and frames.
   4. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
   5. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches (230 mm) o.c. and not more than 2 inches (51 mm) o.c. from each corner.

2.09 STEEL FINISHES:

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

PART 3 - EXECUTION

3.01 PREPARATION:

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.

B. Drill and tap doors and frames to receive non-templated, mortised, and surface-mounted door hardware.

3.02 INSTALLATION:

A. Install hollow-metal doors and frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions.

B. Hollow-Metal Frames: Comply with ANSI/SDI A250.11.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.
    a. Install frames with removable stops located on secure side of opening.
    b. Install door silencers in frames before grouting.
    c. Remove temporary braces necessary for installation only after frames have been properly set and secured.
    d. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
    e. Field apply bituminous coating to backs of frames that will be filled with grout containing anti-freezing agents.
2. Fire-Rated Openings: Install frames in accordance with NFPA 80.
3. Floor Anchors: Secure with post-installed expansion anchors.
    a. Floor anchors may be set with power-actuated fasteners instead of post-installed expansion anchors if so indicated and approved on Shop Drawings.
4. Solidly pack mineral-fiber insulation inside frames.
5. In-Place Concrete: Secure frames in place with post-installed expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
6. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
    a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
    b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
    c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
    d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.

C. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.

1. Non-Fire-Rated Steel Doors: Comply with ANSI/SDI A250.8.
2. Fire-Rated Doors: Install doors with clearances in accordance with NFPA 80.
3. Smoke-Control Doors: Install doors in accordance with NFPA 105.

D. Glazing: Comply with installation requirements in SECTION 08 80 00 "GLAZING" and with hollow-metal manufacturer's written instructions.

3.03 FIELD QUALITY CONTROL:

A. Inspection Agency: Engage a qualified inspector to perform inspections and to furnish reports to Architect.

B. Inspections:

1. Fire-Rated Door Inspections: Inspect each fire-rated door in accordance with NFPA 80, Section 5.2.
2. Egress Door Inspections: Inspect each door equipped with panic hardware, each door equipped with fire exit hardware, each door located in an exit enclosure, each electrically controlled egress door, and each door equipped with special locking arrangements in accordance with NFPA 101, Section 7.2.1.15.

C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

E. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in NFPA 80 and NFPA 101.

3.04 REPAIR:

A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

C. Factory-Finish Touchup: Clean abraded areas and repair with same material used for factory finish according to manufacturer's written instructions.

D. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 08 11 13

SECTION 08 14 16 – FLUSH WOOD DOORS

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. Solid-core flush wood doors with PVC faces.
   2. Interior Sliding Aluminum-Framed Doors and Frames.

1.03 RELATED REQUIREMENTS:

A. SECTION 08 80 00 "GLAZING" for glass view panels in flush wood doors.
B. SECTION 08 88 13 "FIRE-RESISTANT GLAZING" for fire resistant glass view panels in flush wood doors.
C. SECTION 09 91 23 "INTERIOR PAINTING" for field finishing doors.

1.04 REFERENCED STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
B. American National Standards Institute:
   1. ANSI A208.1 - Particleboard.
C. Architectural Woodwork Institute:
   1. Architectural Woodwork Standards.
D. Architectural Woodwork Manufacturers Association of Canada/Woodwork Institute:
   1. North American Architectural Woodwork Standards.
E. Builders Hardware Manufacturers Association:
   1. ANSI/BHMA-156.115W - Hardware Preparation in Wood Doors with Wood or Steel Frames.
F. Door and Hardware Institute:
   1. DHI-WDHS-3 - Recommended Hardware Locations for Wood Flush Doors.
G. National Fire Protection Association:
   1. NFPA 80 - Fire Doors and Other Opening Protectives.
   2. NFPA 105 - Smoke Door Assemblies and Other Opening Protectives.
   3. NFPA 252 - Fire Tests of Door Assemblies.
H. Underwriters Laboratories Inc.:
   1. UL 10C - Positive Pressure Fire Tests of Door Assemblies.
I. Window & Door Manufacturers Association:
   1. WDMA I.S.1-A - Interior Architectural Wood Flush Doors.
   2. WDMA T.M.-10 - Test Method for Determining the Screw Holding Capacity of Wood Doors.

1.05 PREINSTALLATION MEETINGS:

A. Preinstallation Conference: Conduct conference at Project site.

1.06 SUBMITTALS:

A. Product Data: For each type of product, including the following:

1. Door core materials and construction.
2. Door edge construction
3. Door face type and characteristics.
4. Door louvers.
5. Door trim for openings.
6. Door frame construction.
7. Factory-machining criteria.
8. Factory-finishing specifications.

B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each type of door; construction details not covered in Product Data; and the following:
1. Door schedule indicating door and frame location, type, size, fire protection rating, and swing.
2. Door elevations, dimension and locations of hardware, lite and louver cutouts, and glazing thicknesses.
3. Details of frame for each frame type, including dimensions and profile.
4. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
5. Dimensions and locations of blocking for hardware attachment.
6. Dimensions and locations of mortises and holes for hardware.
7. Clearances and undercuts.
8. Requirements for veneer matching.
9. Doors to be factory primed and factory finished and application requirements.

C. Samples for Initial Selection: For high-impact, acrylic modified vinyl faces .

D. Samples for Verification:
1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches (200 by 250 mm), for each material and finish.
2. Polymer edging, in manufacturer's standard colors.
3. Frames for light openings, 6 inches (150 mm) long, for each material, type, and finish required.

E. Sample Warranty: For special warranty.

F. Special warranties.

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

1.07 QUALITY ASSURANCE:

1.08 DELIVERY, STORAGE, AND HANDLING:

A. Comply with requirements of referenced standard and manufacturer's written instructions.

B. Package doors individually in plastic bags or cardboard cartons.

C. Mark each door on top and bottom rail with opening number used on Shop Drawings.

1.09 FIELD CONDITIONS:

A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and HVAC system is operating and maintaining temperature and relative humidity at levels designed for building occupants for the remainder of construction period.

1.10 WARRANTY:

A. Special Warranty: Manufacturer agrees to repair or replace doors and frames that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Delamination of veneer.
      b. Warping (bow, cup, or twist) more than 1/4 inch (6.4 mm) in a 42-by-84-inch (1067-by-2134-mm) section.
      c. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch (0.25 mm in a 76.2-mm) span.
   2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
   3. Warranty Period for Solid-Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Source Limitations: Obtain flush wood doors from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS:

A. Fire-Rated Wood Door and Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated on Drawings, based on testing at positive pressure in accordance with UL 10C or NFPA 252.

B. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing in accordance with UL 1784 and installed in compliance with NFPA 105.

2.03 FLUSH WOOD DOORS, GENERAL:

A. Quality Standard: In addition to requirements specified, comply with ANSI/WDMA I.S. 1A.

2.04 INTERIOR SLIDING ALUMINUM-FRAMED DOORS:

A. Interior Sliding Aluminum-Freamed Doors:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following (Basis of Design is AD Systems: Exam Slide):
      a. Serenity Sliding Door Systems.
   2. Frame Profiles: Extruded aluminum frame “wrap” frame with integral vertical jamb (stile pocket). Frames required to complete seal around door leaf. Gasketing required at all frame to door interfacings. Exposed gaskets at jamb to be silicone.
   3. Finish:
      a. Clear anodized aluminum.
   4. Door Leafs. All Doors to be factory machined for hardware including pilot and function holes. Leading edge of door to be fully finished.
      a. 1-3/4" Flush Wood Door: Reference this Spec SECTION 08 14 16 “FLUSH WOOD DOORS.”
   5. Door Components (Required):
      a. Single Top Track: Anodized finish aluminum track
      b. Valances: Extruded aluminum with integral end caps.
         (1) Sloped valance.

c. Top Rollers: tandem nylon roller sized to match door weight
d. Concealed Floor Guide: Integral Jamb floor guide by AD Systems
e. Soft-Closers: Soft-closing dampeners at [one] both sides of door leaf. Demonstrate soft closers as tested to 150k cycles
f. Door Pull:
(1) 2 ea, Dorma, 830.305 – Beyond, Finish 107
(a) Requires a mounting pack for 1 3/4-in doors.

6. Door Locks where noted in the schedule:
a. Self-Latching Lock with Single Action Egress
b. Finish: US 32D
(1) AD5450P Office—Keyed lock with Cylinder/ADA compliant thumbturn and back to back lever trim. No ladder pulls required
(2) AD5440 Privacy - Keyed lock with Cylinder/ADA compliant thumbturn and back to back lever trim. No ladder pulls required
(3) SFIC required for both locks. Match the existing system.

7. Automatic Door Bottom for improved acoustical performance.

2.05 SOLID-CORE FLUSH WOOD DOORS WITH PVC FACES:

A. Interior Doors:
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
a. Aspiro™ Series (High-impact Doors) | Marshfield-Algoma™ by Masonite Architectural.
2. WDMA Quality Grade: Premium.
3. Performance Grade: ANSI/WDMA I.S. 1A Extra Heavy Duty.
4. Faces: Chemical-and stain-resistant, high-impact, acrylic modified vinyl faces. Color as selected by Architect from manufacturer's full range of wood grain patterns.
5. Vertical Edges: Matching 1/8 inch (3.2mm) high impact edge bonded to structural composite lumber.
6. Horizontal Edges: Structural composite lumber. Clean edge-Bond smooth PVC edge band to structural composite lumber (top & bottom).
7. Core: Structural composite lumber (SCLC).
8. Construction: Standard construction.
9. Thickness: 1-3/4 inch.

B. Solid Core High Impact Flush Doors with Glazed Lites:
1. Match appearance grade and applicable construction and performance requirements of other PVC finish flush wood doors.
2. Factory Glazing: Refer to SECTION 08 80 00 "GLAZING" for glass view panels in flush wood doors. Factory install glass as required. Fill glazing bead nail holes in factory finished doors.
3. Metal Glazing Frames: Manufacturer's standard frame formed of 0.048-inch- (1.2-mm-) thick, cold-rolled steel sheet; with baked-enamel- or powder-coated finish.
a. Frame Design: Metal Vision Frame 110.

C. Fire-Rated High Impact Flush Doors with Glazed Lites <insert drawing designation>:
1. Match appearance grade and applicable construction and performance requirements of non-rated transparent finish flush wood doors.

2. Factory Glazing: Refer to SECTION 08 80 00 "GLAZING" for glass view panels in flush wood doors. Factory install glass as required. Fill glazing bead nail holes in factory finished doors.
3. Glazing: Factory-installed fire-rated safety glass for door rating.
4. Metal Glazing Frames: Manufacturer's standard frame formed of 0.048-inch- (1.2-mm-) thick, cold-rolled steel sheet; with baked-enamel- or powder-coated finis]; and approved for use in doors of fire-protection rating indicated.
   a. Frame Design: Metal Vision Frame 110.

2.06 LIGHT FRAMES:

A. Metal Frames for Light Openings in Fire-Rated Doors: Manufacturer's standard frame formed of 0.048-inch- (1.2-mm-) thick, cold-rolled steel sheet; with baked-enamel- or powder-coated finish; and approved for use in doors of fire-protection rating indicated on Drawings.

2.07 FABRICATION:

A. Factory fit doors to suit frame-opening sizes indicated.
   1. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
   2. Comply with NFPA 80 requirements for fire-rated doors.
B. Factory machine doors for hardware that is not surface applied.
   1. Locate hardware to comply with DHI-WDHS-3.
   2. Comply with final hardware schedules, door frame Shop Drawings, ANSI/BHMA-156.115-W, and hardware templates.
   3. Coordinate with hardware mortises in metal frames, to verify dimensions and alignment before factory machining.
   4. For doors scheduled to receive electrified locksets, provide factory-installed raceway and wiring to accommodate specified hardware.
   5. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.
C. Transom and Side Panels:
   1. Fabricate matching panels with same construction, exposed surfaces, and finish as specified for associated doors.
D. Openings: Factory cut and trim openings through doors.
   1. Light Openings: Trim openings with moldings of material and profile indicated.
   2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in SECTION 08 80 00 "GLAZING" and SECTION 08 88 13 "FIRE-RESISTANT GLAZING."

2.08 FACTORY FINISHING:

A. Comply with referenced quality standard for factory finishing.
   1. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
   2. Finish faces, all four edges, edges of cutouts, and mortises.
B. Factory finish doors where indicated in schedules or on Drawings as factory finished.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine doors and installed door frames, with Installer present, before hanging doors.
   1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
   2. Reject doors with defects.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:

A. Hardware: For installation, see SECTION 08 71 11 "DOOR HARDWARE (DESCRIPTIVE SPECIFICATION)."
B. Install doors and frames to comply with manufacturer's written instructions and referenced quality standard, and as indicated.
C. Install frames level, plumb, true, and straight.
   1. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches (3.2 mm in 2400 mm).
   2. Anchor frames to anchors or blocking built in or directly attached to substrates.
      a. Secure with countersunk, concealed fasteners and blind nailing.
      b. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork.
         (1) For factory-finished items, use filler matching finish of items being installed.
   3. Install fire-rated doors and frames in accordance with NFPA 80.
   4. Install smoke- and draft-control doors in accordance with NFPA 105.
D. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
   1. Undercuts shall be a maximum of 3/4-inch
E. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.03 ADJUSTING:

A. Operation: Rehang or replace doors that do not swing or operate freely.
B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 08 14 16

SECTION 08 31 13 – ACCESS DOORS AND FRAMES

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 access doors and frames for walls and ceilings.

1.03 RELATED REQUIREMENTS:

A. SECTION 07 72 00 "ROOF ACCESSORIES" for roof hatches.

1.04 REFERENCED STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. ASTM International:

1. ASTM A 36/A 36M - Specification for Carbon Structural Steel.
2. ASTM A 153/A 153M - Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
3. ASTM A 653/A 653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
4. ASTM A 879/A 879M - Specification for Steel Sheet, Zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface.
5. ASTM A 1008/A 1008M - Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
6. ASTM F 2329/F 2329M - Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.

C. National Fire Protection Association:

1. NFPA 80 - Fire Doors and Other Opening Protectives.
2. NFPA 252 - Fire Tests of Door Assemblies.

D. Underwriters Laboratories Inc.:

1. UL 10B - Fire Tests of Door Assemblies.

1.05 SUBMITTALS:

A. Product Data: For each type of product.

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

B. Samples: For each type of access door and frame and for each finish specified, complete assembly minimum 6 by 6 inches (150 by 150 mm) in size.

C. Product Schedule: For access doors and frames.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. Fire-Rated Access Doors and Frames: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, according to NFPA 252 or UL 10B.

2.02 ACCESS DOORS AND FRAMES:

A. Flush Access Doors with Exposed Flanges:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Milcor Inc.; DW or comparable product by one of the following:
      a. Babcock-Davis.
      b. JL Industries, Inc.; a division of the Activar Construction Products Group.
      c. Maxam Metal Products Limited.
      d. Nystrom, Inc.
   2. Description: Face of door flush with frame, with exposed flange and concealed hinge.
   3. Locations: Wall and ceiling.
   4. Door Size: As indicated on the drawings.
   5. Uncoated Steel Sheet for Door: Nominal 0.060 inch (1.52 mm), 16 gage, factory primed.
   6. Frame Material: Same material, thickness, and finish as door.
   7. Latch and Lock: Self-latching door hardware, prepared for mortise cylinder.
      a. Lock Cylinder: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver.
         (1) Basis-of-Design Product: Subject to compliance with requirements, provide Best Access Systems; Stanley Security Solutions, Inc.; 1E-64 or comparable product by one of the following:
            (a) Corbin Russwin, Inc.; an ASSA ABLOY Group company.
            (b) SARGENT Manufacturing Company; ASSA ABLOY.
            (c) Schlage.
            (d) Yale Security Inc; an ASSA ABLOY Group company.
      b. Standard Lock Cylinders: BHMA A156.5; Grade 1 permanent cores; face finished to match lockset.
         (1) Core Type: Interchangeable.
            (a) Interchangable cores are to be Owner furnished.
         (2) Number of Pins:: Seven.
         (3) Lock Type: Mortise type.

B. Flush Access Doors with Concealed Flanges:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Milcor Inc.; DWR or comparable product by one of the following:
      a. Babcock-Davis.
      b. JL Industries, Inc.; a division of the Activar Construction Products Group.
      c. Nystrom, Inc.
   2. Description: Face of door flush with frame; with concealed flange for gypsum board installation and concealed hinge.
   3. Locations: Wall and ceiling.
   4. Door Size: As indicated on the drawings.
   5. Uncoated Steel Sheet for Door: Nominal 0.060 inch (1.52 mm), 16 gage, factory primed.
   6. Frame Material: Same material and thickness as door.

7. Latch and Lock: Self-latching door hardware, prepared for mortise cylinder.
   a. Lock Cylinder: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver.
      (1) Basis-of-Design Product: Subject to compliance with requirements, provide Best Access Systems; Stanley Security Solutions, Inc.; 1E-64 or comparable product by one of the following:
         (a) Corbin Russwin, Inc.; an ASSA ABLOY Group company.
         (b) SARGENT Manufacturing Company; ASSA ABLOY.
         (c) Schlage.
         (d) Yale Security Inc; an ASSA ABLOY Group company.
   b. Standard Lock Cylinders: BHMA A156.5; Grade 1 permanent cores; face finished to match lockset.
      (1) Core Type: Interchangeable.
         (a) Interchangable cores are to be Owner furnished.
      (2) Number of Pins:: Seven.
      (3) Lock Type: Mortise type.

2.03 FIRE-RATED ACCESS DOORS AND FRAMES:

A. Fire-Rated, Flush Access Doors with Exposed Flanges; **AD-3**:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Milcor Inc.; UFR or comparable product by one of the following:
      a. Babcock-Davis.
      b. JL Industries, Inc.; a division of the Activar Construction Products Group.
      c. Maxam Metal Products Limited.
      d. Nystrom, Inc.
   2. Description: Door face flush with frame, with a core of mineral-fiber insulation enclosed in sheet metal; with exposed flange, self-closing door, and concealed hinge.
   3. Locations: Wall and ceiling.
   4. Door Size: As indicated on the drawings.
   5. Fire-Resistance Rating: Not less thanthat indicated .
   6. Uncoated Steel Sheet for Door: Nominal 0.036 inch (0.91 mm), 20 gage, factory primed.
   7. Frame Material: Same material, thickness, and finish as door.
   8. Latch and Lock: Self-latching door hardware, prepared for mortise cylinder.
      a. Lock Cylinder: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver.
         (1) Basis-of-Design Product: Subject to compliance with requirements, provide Best Access Systems; Stanley Security Solutions, Inc.; 1E-64 or comparable product by one of the following:
            (a) Corbin Russwin, Inc.; an ASSA ABLOY Group company.
            (b) SARGENT Manufacturing Company; ASSA ABLOY.
            (c) Schlage.
            (d) Yale Security Inc; an ASSA ABLOY Group company.
      b. Standard Lock Cylinders: BHMA A156.5; Grade 1 permanent cores; face finished to match lockset.
         (1) Core Type: Interchangeable.
            (a) Interchangable cores are to be Owner furnished.
         (2) Number of Pins:: Seven.
         (3) Lock Type: Mortise type.

B. Fire-Rated, Flush Access Doors with Concealed Flanges; :
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Nystrom Inc.; IW or comparable product by one of the following:
      a. Acudor Products, Inc.
      b. Babcock-Davis.
      c. JL Industries, Inc.; a division of the Activar Construction Products Group.
      d. Maxam Metal Products Limited.
   2. Description: Door face flush with frame, with a core of mineral-fiber insulation enclosed in sheet metal; with concealed flange for gypsum board installation, self-closing door, and concealed hinge.
   3. Locations: Wall and ceiling.
   4. Door Size: As indicated on Drawings.
   5. Fire-Resistance Rating: Not less than that indicated .
   6. Uncoated Steel Sheet for Door: Nominal 0.036 inch (0.91 mm), 20 gage, factory primed.
   7. Latch and Lock: Self-closing, self-latching door hardware, prepared for mortise cylinder.
      a. Lock Cylinder: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver.
         (1) Basis-of-Design Product: Subject to compliance with requirements, provide Best Access Systems; Stanley Security Solutions, Inc.; 1E-64 or comparable product by one of the following:
            (a) Corbin Russwin, Inc.; an ASSA ABLOY Group company.
            (b) SARGENT Manufacturing Company; ASSA ABLOY.
            (c) Schlage.
            (d) Yale Security Inc; an ASSA ABLOY Group company.
      b. Standard Lock Cylinders: BHMA A156.5; Grade 1 permanent cores; face finished to match lockset.
         (1) Core Type: Interchangeable.
            (a) Interchangable cores are to be Owner furnished.
         (2) Number of Pins:: Seven.
         (3) Lock Type: Mortise type.

2.04 MATERIALS:

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879/A 879M, with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.
C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.
D. Frame Anchors: Same material as door face.
E. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329/F 2329M.

2.05 FABRICATION:

A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.
   1. For concealed flanges with drywall bead, provide edge trim for gypsum panels securely attached to perimeter of frames.
   2. For concealed flanges with plaster bead for full-bed plaster applications, provide zinc-coated expanded-metal lath and exposed casing bead welded to perimeter of frames.

D. Recessed Access Doors: Form face of panel to provide recess for application of applied finish. Reinforce panel as required to prevent buckling. Provide access sleeves for each latch operator and install in holes cut through finish.

E. Latch and Lock Hardware:
   1. Quantity: Furnish number of latches and locks required to hold doors tightly closed.

2.06 FINISHES:

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

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:

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

3.03 ADJUSTING:

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

END OF SECTION 08 31 13

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SECTION 08 42 43 - INTENSIVE CARE UNIT/CRITICAL CARE UNIT (ICU/CCU) ENTRANCES

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 manually operated, intensive care unit/critical care unit (ICU/CCU) entrances located in T1381

1.03 COORDINATION:

A. Recesses: Coordinate sizes and locations of recesses in concrete floors for recessed tracks. Concrete, reinforcement, and formwork requirements are specified elsewhere.

B. Templates: Distribute for doors, frames, and other work specified to be factory prepared for installing ICU/CCU entrances.

1.04 ACTION SUBMITTALS:

A. Product Data: For each configuration of ICU/CCU entrance indicated.

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

B. Shop Drawings: For each ICU/CCU installation.

1. Include plans, elevations, sections, hardware mounting heights, and attachment details.

C. Samples for Initial Selection: For units with factory-applied color and metal-cladding finishes.

1.05 INFORMATIONAL SUBMITTALS:

A. Sample Warranties: For manufacturer's warranties.

1.06 QUALITY ASSURANCE:

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.07 FIELD CONDITIONS:

A. Field Measurements: Verify actual dimensions of openings to receive ICU/CCU entrances by field measurements before fabrication.

1.08 WARRANTY:

A. Special Warranty: Manufacturer agrees to repair or replace components of ICU/CCU entrances that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
    a. Structural failures including, but not limited to, excessive deflection.
    b. Faulty operation of hardware.
    c. Deterioration of metals, metal finishes, and other materials beyond normal use.
2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS, GENERAL:

A. Source Limitations: Obtain each type of ICU/CCU entrance from single source from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS:

A. Opening Force: Not more than 5 lbf (22.2 N) to fully open door.

B. Air Leakage: Entrance assemblies for smoke control and pressurized rooms shall be listed and labeled for smoke and draft control by qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and having maximum air leakage according to NFPA 105 unless otherwise indicated.

2.03 SLIDING ICU/CCU ENTRANCE ASSEMBLIES:

A. General: Provide manufacturer's factory-glazed ICU/CCU entrances indicated including door leaves, sidelites, framing, headers, carrier assemblies, roller tracks, and accessories required for a complete installation.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Horton Automatics; a division of Overhead Door Corporation or a comparable product by one of the following:
   a. Besam Entrance Solutions; an ASSA ABLOY Group Company.
   b. DORMA USA, Inc.
   c. Stanley Access Technologies.

B. Breakaway Hardware: Release hardware that allows indicated panels to swing out in direction of egress to full 90 degrees from closed door position.

1. Maximum Force to Open Panel: 50 lbf (222 N).
2. Release Position: Sliding door fully open.

C. Manual Sliding ICU/CCU Entrance:

1. IV Start Room, T1377
2. Performance: Smoke-control assembly or Pressurized-entrance assembly .
3. Configuration: Single-telescoping three-panel door, with two operable leaves and one sidelite; with breakaway hardware for sliding leaves and sidelite.
4. Floor Track Configuration: No track across sliding door opening and at sidelites (trackless).
5. Stile Design: Narrow stile; 2-1/8-inch (55-mm) nominal width.
6. Rail Design: 3-1/2-inch (90-mm) nominal height.
7. Muntin Bars: On doors and sidelites.
8. Glazing Stops and Gaskets: Beveled.
9. Glazing: Clear tempered.
10. Finish framing, door(s), sidelite(s), and header with Class II, clear anodic finish.

2.04 COMPONENTS:

A. Framing Members: Extruded aluminum, minimum 0.125 inch (3.2 mm) thick and reinforced as required to support imposed loads.

1. Nominal Size: 1-3/4 by 4-1/2 inches (45 by 115 mm).

B. Stile and Rail Doors: 1-3/4-inch- (45-mm-) thick, glazed doors with minimum 0.125-inch- (3.2-mm-) thick, extruded-aluminum tubular stile and rail members. Mechanically fasten corners with

reinforcing brackets that are welded, or incorporate concealed tie rods that span full length of top and bottom rails.

1. Glazing Stops and Gaskets: Snap-on, extruded-aluminum stops and preformed gaskets for glazing indicated.
2. Muntin Bars: Horizontal tubular rail member for each door; match stile design.

C. Sidelites: 1-3/4-inch- (45-mm-) deep sidelites with minimum 0.125-inch- (3.2-mm-) thick, extruded-aluminum tubular stile and rail members matching door design and finish.
   1. Glazing Stops and Gaskets: Same materials and design as for stile and rail door.
   2. Muntin Bars: Horizontal tubular rail member for each sidelite; match stile design.

D. Glazing: As specified in SECTION 08 80 00 "GLAZING."

E. Headers: Fabricated from minimum 0.125-inch- (3.2-mm-) thick, extruded aluminum, and extending full width of ICU/CCU entrance units to conceal carrier assemblies and roller tracks. Provide hinged or removable access panels for service and adjustment. Secure panels to prevent unauthorized access.
   1. Capacity: Capable of supporting doors up to 100 lb (45 kg) per leaf over spans up to 14 feet (4.3 m) without intermediate supports.
   2. Provide sag rods for spans exceeding 14 feet (4.3 m).

F. Carrier Assemblies and Overhead Roller Tracks: Assembly that allows vertical adjustment; consisting of nylon- or polyoxymethylene (POM)-covered, ball-bearing-center steel wheels operating on a continuous roller track or of ball-bearing-center steel wheels operating on a nylon- or POM-covered, continuous roller track. Support doors from carrier assembly by cantilever and pivot assembly. Provide minimum of two ball-bearing roller wheels and two antirise rollers for each active leaf.

G. Brackets and Reinforcements: High-strength aluminum with nonstaining, nonferrous shims for aligning system components.

H. Fasteners and Accessories: Corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

2.05 HARDWARE:

A. General: Provide units in sizes and types recommended by ICU/CCU entrance and hardware manufacturers for entrances and uses indicated. Finish exposed parts to match door finish unless otherwise indicated.

B. Pulls: Recessed units on both sides of each operable door..

C. Manual Flush Bolts: BHMA A156.16, Grade 1, edge mortised, lever-extension type; located at bottom of each swing-out sidelite.

D. Positive Latch: BHMA A156.5, Grade 1, manufacturer's standard latch and strike with lever handles on each side of swinging door panels. Manual flush bolt latch at each swing-out sidelite.

2.06 FABRICATION:

A. General: Factory fabricate ICU/CCU entrance components to designs, sizes, and thicknesses indicated and to comply with indicated standards.
   1. Fabricate aluminum components before finishing.
   2. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
   3. Use concealed fasteners to greatest extent possible. Where exposed fasteners are required, use countersunk Phillips flat-head machine screws, finished to match framing.

a. Where fasteners are subject to loosening or turning out from structural movements or vibration, use self-locking devices.
b. Reinforce members as required to receive fastener threads.

4. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.

B. Framing: Provide ICU/CCU entrances as prefabricated assemblies. Complete fabrication, assembly, finishing, hardware application, and other work before shipment to Project site.
1. Fabricate tubular and channel frame assemblies with welded or mechanical joints. Provide subframes 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 straight and free of defects or deformations.
4. Provide components with 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.
6. Provide anchorage and alignment brackets for concealed support of assembly from the building structure.

C. Doors: Factory fabricated and assembled in profiles indicated. Reinforce as required to support imposed loads and for installing hardware.

D. Glazing: Fabricate framing with minimum glazing edge clearances for thickness and type of glazing indicated, according to GANA's "Glazing Manual."

E. Factory Glazing: Install glazing at the factory.

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. Cut, drill, and tap for factory-installed hardware before applying finishes.
1. Provide sliding weather stripping, mortised into door, at perimeter of sliding surfaces and breakaway sidelites.

G. Electrical Grounding: Fabricate ICU/CCU entrances to be internally grounded, complying with requirements of authorities having jurisdiction.

2.07 MATERIALS:

A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
1. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221
2. Sheet and Plate: ASTM B209.

B. Sealants and Joint Fillers: As specified in SECTION 07 92 00 "JOINT SEALANTS."

C. Shrinkage-Resistant Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout complying with ASTM C1107/C1107M; of consistency suitable for application.

D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.08 GENERAL FINISH REQUIREMENTS:

A. Comply with NAAMM/NOMMA 500 for recommendations for applying and designating finishes.

B. Apply organic and anodic finishes to formed metal after fabrication unless otherwise indicated.

C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.09 ALUMINUM FINISHES:

A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances, header support, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:

A. Install ICU/CCU entrances plumb, true in alignment with established lines and grades, and 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.
3. Air Leakage: Install entrance assemblies for smoke-control and pressurized rooms according to NFPA 105 and as indicated.

B. Sealants: Comply with requirements in SECTION 07 92 00 "JOINT SEALANTS" for installing sealants, fillers, and gaskets.

1. Set framing members, floor tracks, and flashings in full sealant bed.
2. Seal perimeter of framing members with sealant.

C. Grounding: Comply with requirements in SECTION 26 05 26 "GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS."

3.03 ADJUSTING:

A. Adjust operating hardware and moving parts to function smoothly and lubricate as recommended by manufacturer.

B. Adjust force to open door panels.

C. Test grounding system for compliance with requirements of authorities having jurisdiction.

D. Adjust smoke-control and pressurized-entrance doors for tight closure.

3.04 CLEANING AND PROTECTION:

A. Clean glass and metal surfaces promptly after installation. Remove excess glazing and sealant compounds, dirt, and other substances. Repair damaged finish to match original finish.

B. Comply with requirements in SECTION 08 80 00 "GLAZING" for cleaning and protecting glass.

END OF SECTION 08 42 43

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SECTION 08 71 11 – DOOR HARDWARE

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 finish hardware for the proper operation and control of all doors in the Project. Prior to bidding, notify Architect of any doors that do not have hardware meeting this intention.

B. Hardware supplier will be responsible to furnish and install hardware on labeled doors to satisfy State and Local Building Codes.

C. Related Sections include the following:

1. DIVISION 08 SECTION "HOLLOW METAL DOORS AND FRAMES."
2. DIVISION 08 SECTION "FLUSH WOOD DOORS."

1.03 SUBMITTALS:

A. Product Data: For each product and material indicated, submit manufacturer's technical product data. Include information necessary to show compliance with requirements, installation instructions and maintenance instructions.

B. Hardware Schedule: Submit a hardware schedule organized into sets, including the information below. Designations for door numbers and hardware sets shall match those used in the construction documents.

1. Opening Number
2. Door Type and Size
3. Frame Type and Size
4. Frame Anchoring Method
5. Hardware Set
6. Assembly Rating

C. Hardware Schedule shall be coordinated with the doors, frames and related work to ensure proper size, thickness, hand function and finish of door hardware

1.04 QUALITY ASSURANCE:

A. Supplier Qualifications: A recognized Architectural Finish Hardware Supplier, with warehousing facilities, who has been furnishing hardware in the Project's vicinity for a period of not less than two (2) years. Supplier shall be or employ an experienced Architectural Hardware Consultant (AHC) who is certified by and member of the Door and Hardware Institute. The Architectural hardware Consultant shall be available, at reasonable times during the course of the work, for consultation about Project's hardware requirements, to Owner, Architect and Contractor.

B. Fire-Rated Openings: Provide hardware for fire-rated openings in compliance with NFPA Standard No. 80, No. 101 and local building code requirements. Provide only hardware, which has been tested and listed, by UL, FM or Warnock Hersey for types and sizes of doors required and complies with requirements of door and door frame labels.

C. Standards: Comply with the requirements of the latest edition of the following standards unless indicated otherwise:

1. American National Standards Institute Publications:
   a. A115 Series – Door and Frame Preparation
   b. A156 Series – Hardware

2. Builders Hardware Manufacturer's Association Publications:
   a. 1201 – Auxiliary Hardware
   b. 1301 – Materials and Finishes
3. Door and Hardware Institute Publications:
   a. Keying – Procedures, Systems and Nomenclature
   b. Abbreviations and Symbols
   c. Hardware for Labeled Fire Doors
   d. Recommended Locations for Builder's Hardware for Standard and Custom Steel Doors and Frames
   e. Wood Door Standards W1, W2, WDHS-2, WDHS-3
4. National Fire Protection Association Publications
   a. NFPA 80 – Standards for Fire Doors and Windows
   b. NFPA 101 – Life Safety Code
5. International Building Code – 2015 Edition
6. American with Disabilities Act.

1.05 DELIVERY, STORAGE, AND HANDLING:

A. Package each hardware item in separate containers with all screws, wrenches, installation instructions and installation templates. Mark each box with hardware heading and door number according to approved hardware schedule.

B. Deliver individually packaged hardware items at the proper times to the proper locations (shop or project site) for installation: Provide a complete packing list showing items, door numbers and hardware headings with each shipment.

C. Store hardware in shipping cartons above ground and under cover to prevent damage. Provide secure lockup for door hardware delivered to the Project, but not yet installed. Control handling and installation of hardware items that are not immediately replaceable -so that completion of the Work will not be delayed by hardware losses both before and after installation.

1.06 PROJECT CONDITIONS:

A. Environmental Limitations: Do not proceed with delivery and/or installation when ambient and substrate temperature conditions are outside limits permitted by material manufacturers.

PART 2 - PRODUCTS

2.01 HARDWARE GENERAL:

A. Provide the materials of products indicated by trade names, manufacturer's name, or catalog number. Substitutions will not be permitted except as described in DIVISION 01.

B. Provide manufacturer's standard products meeting the design intent of this Specification, free of imperfections affecting appearance or serviceability.
   1. Provide hardware complete with all fasteners, anchors, instructions, layout templates, and any specialized tools as required for satisfactory installation and adjustment.
   2. Hand of Door: Drawings show direction of slide, swing or hand of each door leaf. Furnish each item of hardware for proper installation and operation of door movement as shown.
   3. Furnish screws for installation with each hardware item. Provide Phillips flat head screws except as otherwise indicated or approved. Finish screws exposed under any condition to match hardware finish, or, if exposed in surface of other work, to match finish of such other work as closely as possible. Use machine screws for metal connections and wood screws for connections to wood. Use manufacturer's screws to secure hardware.

4. Provide concealed fasteners for hardware unit with care exposed when door is closed, except to extent no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt, head or nut on opposite face is exposed in other work, except where indicated otherwise or where it is not feasible to adequately reinforce the work. In such cases, provide sleeves for each thru-bolt or use sex screw fasteners.
5. Special Tools: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance and removal and replacement of finish hardware.

C. Hardware is specified in the hardware schedule by set, type and functions, which have been selected as best meeting the application requirements. Acceptable products for each category are specified in Paragraph 2.5 "Hardware Products".

2.02 SPECIAL REQUIREMENTS:

A. General:
1. Where new doors and hardware are scheduled to be installed in existing frames, contractor to coordinate hinge sizes and locations, lockset backsets, strikes, hardware mounting heights, etc with existing frames to ensure new door and hardware fits and functions properly in existing frame.

B. Hinges:
1. Use heavy weight hinges for all doors.

C. Locksets:
1. All locksets to be grade 1 heavy duty cylindrical or as specified.

D. Closers:
1. Comply with manufacturer's recommendations for unit size based on door size and usage.
2. Provide parallel arms for all overhead closers, except as otherwise indicated.
3. All closers UL Listed Certified to be n compliance with UBC 7.2 and UL 10C.
4. Closers with Pressure Relief Valves will not be acceptable.
5. Supplier to provide any brackets or plates required for proper installation of door closers.

E. Exit Devices:
1. All latchbolts to be deadlatching type.
2. All touchbars to be stainless steel.

2.03 KEYING:

A. Contractor to turn all cylinders over to MU key shop for keying.

2.04 FINISHES:

A. Standard: Comply with BHMA A156.18
1. All door hardware to be US26D throughout project.

B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the application units of hardware.

C. Protect finishes on exposed surfaces from any damage by applying a strippable temporary protective covering before shipping.

D. BHMA Designations: Comply with base material and finish requirements indicated by BHMA standards.

2.05 HARDARE PRODUCTS:

ITEM	SPECIFIED	APPROVED EQUAL

Hinges	Ives	Stanley
Locksets	Schlage	Best, Corbin Russwin
Cylinders	Best	No Substitution
Closers	LCN	No Substitution
Panic Devices	Von Duprin	Sargent, Yale
Flatgoods	Ives	Burns, Rockwood
Stops	Ives	Burns, Rockwood
Overhead Stops	Glynn Johnson	Rixson
Gasket	Zero	NGP, Reese
Electric Strikes	Adams Rite	No Substitution
Prox Card Readers	HIDR	No Substitution
Auto Operators	Horton	No Substitution

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine doors and frames with installer present for compliance with the requirements, for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Examine rough-in for electrical source power to verify actual locations of wiring connections before electrified door hardware installation.

C. Notify Architect of any discrepancies or conflicts between the door schedule, door types, frame types, drawings, scheduled hardware and built condition.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:

A. Steel Frames: Comply with ANSI/DHI A115 Series

B. Wood Doors: Comply with ANSI/DHI A115-W Series.

3.03 INSTALLATION:

A. Mounting Heights: Mount door hardware units at heights indicated in the following applicable publications, or as required to comply with governing regulations:

1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
2. Custom Steel Doors and Frames: DHI's "Recommended Locations for Builder's Hardware for Custom Steel Doors and Frames."
3. Wood Doors: DHI WDHS.2 "Recommended Locations for Architectural Hardware for Wood Flush Doors."

B. Install each door hardware item to complete with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage and reinstallation of surface protective trim units to with finishing work. Do not install surface mounted items until finishes have been completed on substrates involved.

3.04 FIELD QUALITY CONTROL:

A. Field Inspection: Supplier will perform a final inspection of installed door hardware and state in written report whether work complies with or deviates from requirements, including whether door hardware is properly installed, operating and adjusted.

3.05 ADJUSTING:

A. Initial Adjustment: Adjust and check each operating items of door hardware and each door to ensure proper operation of function of every unit. Replace units that cannot be adjusted to operate as intended and/or required. Adjust door control devices to compensation for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.06 CLEANING AND PROTECTION:

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper finish, and provide final protection and maintain condition that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.07 DEMOSTRATION AND TRAINING:

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate and maintain door hardware and door hardware finishes.

3.08 DOOR HARDWARE SETS:

HARDWARE SET: 01 - Not Used

HARDWARE SET: 01A
FOR USE ON DOOR #(S):
T1380 TC1307
PROVIDE EACH PR DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
6	EA	HINGE	5BB1HW X SIZE AS REQ'D	652	IVE
2	EA	FIRE EXIT HARDWARE	9927-EO-F-LBR-499F	626	VON
1	EA	DELAYED EGRESS MAG	M490DEP 12/24 VDC	628	SCE
2	EA	SURFACE CLOSER	4040XP EDA	689	LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS	630	IVE
2	EA	WALL MAGNET	SEM7850 12V/24V/120V	689	LCN
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	ASTRAGAL (SET)	8193AA	AA	ZER
1	EA	POWER SUPPLY	BY SECURITY CONTRACTOR		
1	EA	WIRING DIAGRAMS	BY SECURITY CONTRACTOR		
1	EA	CARD ACCESS	BY SECURITY CONTRACTOR		

OPERATION: DOORS EITHER HELD OPEN ON WALL MAGNETS, OR CLOSED AND LOCKED. WHEN CLOSED, ENTRY TO TREATMENT AREA BY CARD READER, MOMENTARILY RELEASING MAGNETIC LOCK. DOOR SWINGING OUT OF TREATMENT AREA ALWAYS FREE EGRESS BY EXIT DEVICE PUSH PAD. MAGNETIC LOCK AND MAGNETIC HOLDERS TO RELEASE UPON FIRE ALARM ACTIVATION.

HARDWARE SET: 02

FOR USE ON DOOR #(S):

T1262 T1263 T1346 T1347 T1348 T1362 T1369

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW X SIZE AS REQ'D	652	IVE
1	EA	SFIC	OWNER PROVIDED	626	BES
1	EA	STOREROOM LOCK	ND80BD SPA	626	SCH
1	EA	ELECTRIC STRIKE	7200 SERIES	630	ADA
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	626	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	DOOR CONTACT	679-05 HM/WD AS REQ'D	BLK	SCE
1	EA	MOTION SENSOR	SCANII 12/24 VDC	BLK	SCE
1	EA	POWER SUPPLY	BY SECURITY CONTRACTOR		
1	EA	WIRING DIAGRAMS	BY SECURITY CONTRACTOR		
1	EA	CARD ACCESS	BY SECURITY CONTRACTOR		

OPERATION: DOOR NORMALLY CLOSED AND LOCKED. ENTRY BY CARD READER, MOMENTARILY RELEASING ELECTRIC STRIKE. INSIDE LEVER ALWAYS FREE EGRESS.

HARDWARE SET: 02A

FOR USE ON DOOR #(S):

T1370

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW X SIZE AS REQ'D	652	IVE
1	EA	SFIC	OWNER PROVIDED	626	BES
1	EA	ELEC FIRE EXIT HARDWARE	RX-LC-QEL-99-L-F-17 24 VDC	626	VON
1	EA	SFIC RIM HOUSING	80-129	626	SCH
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	626	IVE
1	EA	WALL MAGNET	SEM7850 12V/24V/120V	689	LCN
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	DOOR CONTACT	679-05 HM/WD AS REQ'D	BLK	SCE
1	EA	POWER SUPPLY	PS902 900-2RS 120/240 VAC	LGR	SCE
1	EA	WIRING DIAGRAMS	BY SECURITY CONTRACTOR		
1	EA	CARD ACCESS	BY SECURITY CONTRACTOR		

OPERATION: DOOR HELD ON WALL MAGNET WHEN DESIRED. WHEN CLOSED AND LOCKED, ENTRY BY CARD READER, MOMENTARILY RETRACTING DEVICE LATCH. INSIDE PUSH PAD ALWAYS FREE EGRESS. WALL MAGNET TO RELEASE UPON FIRE ALARM ACTIVATION.

HARDWARE SET: 03
FOR USE ON DOOR #(S):
T1260 T1266
PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW X SIZE AS REQ'D	652	IVE
1	EA	SFIC	OWNER PROVIDED	626	BES
1	EA	STOREROOM LOCK	ND80BD SPA	626	SCH
1	EA	ELECTRIC STRIKE	7200 SERIES	630	ADA
1	EA	SURFACE CLOSER	4011 DEL	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	626	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	DOOR CONTACT	679-05 HM/WD AS REQ'D	BLK	SCE
1	EA	MOTION SENSOR	SCANII 12/24 VDC	BLK	SCE
1	EA	POWER SUPPLY	BY SECURITY CONTRACTOR		
1	EA	WIRING DIAGRAMS	BY SECURITY CONTRACTOR		
1	EA	CARD ACCESS	BY SECURITY CONTRACTOR		

OPERATION: DOOR NORMALLY CLOSED AND LOCKED. ENTRY BY CARD READER, MOMENTARILY RELEASING ELECTRIC STRIKE. INSIDE LEVER ALWAYS FREE EGRESS.

HARDWARE SET: 04
FOR USE ON DOOR #(S):
T1345 T1368A T1368B
PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW X SIZE AS REQ'D	652	IVE
1	EA	SFIC	OWNER PROVIDED	626	BES
1	EA	STOREROOM LOCK	ND80BD SPA	626	SCH
1	EA	ELECTRIC STRIKE	7200 SERIES	630	ADA
1	EA	OH STOP	90S	630	GLY
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	DOOR CONTACT	679-05 HM/WD AS REQ'D	BLK	SCE
1	EA	MOTION SENSOR	SCANII 12/24 VDC	BLK	SCE
1	EA	POWER SUPPLY	BY SECURITY CONTRACTOR		
1	EA	WIRING DIAGRAMS	BY SECURITY CONTRACTOR		
1	EA	CARD ACCESS	BY SECURITY CONTRACTOR		

OPERATION: DOOR NORMALLY CLOSED AND LOCKED. ENTRY BY CARD READER, MOMENTARILY RELEASING ELECTRIC STRIKE. INSIDE LEVER ALWAYS FREE EGRESS.

HARDWARE SET: 05

FOR USE ON DOOR #(S):

T1261

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW X SIZE AS REQ'D	652	IVE
1	EA	SFIC	OWNER PROVIDED	626	BES
1	EA	STOREROOM W/DEADBOLT	L9480BDC 17A L583-363	626	SCH
1	EA	ELECTRIC STRIKE	6216 FSE 12/16/24/28 VAC/VDC	630	VON
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	626	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	DOOR CONTACT	679-05 HM/WD AS REQ'D	BLK	SCE
1	EA	MOTION SENSOR	SCANII 12/24 VDC	BLK	SCE
1	EA	POWER SUPPLY	BY SECURITY CONTRACTOR		
1	EA	WIRING DIAGRAMS	BY SECURITY CONTRACTOR		
1	EA	CARD ACCESS	BY SECURITY CONTRACTOR		

OPERATION: DOOR NORMALLY CLOSED AND LOCKED. ENTRY BY CARD READER, MOMENTARILY RELEASING ELECTRIC STRIKE. THROWING DEADBOLT FROM INSIDE LOCKS DOOR FOR PRIVACY AND FROM CARD READER USE UNTIL DEADBOLT RETRACTED. INSIDE LEVER RETRACTS LATCHBOLT AND DEADBOLT SIMULTANEOUSLY.

HARDWARE SET: 06

FOR USE ON DOOR #(S):

T1365 T1371

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW X SIZE AS REQ'D	652	IVE
1	EA	SFIC	OWNER PROVIDED	626	BES
1	EA	STOREROOM LOCK	ND80BD SPA	626	SCH
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	626	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

HARDWARE SET: 07
FOR USE ON DOOR #(S):
T1366
PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW X SIZE AS REQ'D	652	IVE
1	EA	SFIC	OWNER PROVIDED	626	BES
1	EA	STOREROOM LOCK	ND80BD SPA	626	SCH
1	EA	SURFACE CLOSER	4040XP EDA	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	626	IVE
1	EA	GASKETING	488SBK PSA (AT RATED DOORS)	BK	ZER
3	EA	SILENCER	SR64 (AT NON-RATED DOORS)	GRY	IVE

HARDWARE SET: 07A
FOR USE ON DOOR #(S):
T1376
PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW X SIZE AS REQ'D	652	IVE
1	EA	SFIC	OWNER PROVIDED	626	BES
1	EA	STOREROOM LOCK	ND80BD SPA	626	SCH
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	626	IVE
1	EA	GASKETING	488SBK PSA (AT RATED DOORS)	BK	ZER
3	EA	SILENCER	SR64 (AT NON-RATED DOORS)	GRY	IVE

HARDWARE SET: 08
FOR USE ON DOOR #(S):
T1264 T1265 T1364
PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW X SIZE AS REQ'D	652	IVE
1	EA	SFIC	OWNER PROVIDED	626	BES
1	EA	ENTRANCE LOCK	ND53BD SPA	626	SCH
1	EA	WALL STOP	WS406/407CCV	626	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

HARDWARE SET: 09
FOR USE ON DOOR #(S):
T1373
PROVIDE EACH PR DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	PIVOT SET	7226F SET	630	IVE
2	EA	INTERMEDIATE PIVOT	7226F INT	630	IVE
1	EA	AUTO FLUSH BOLT	FB31T	630	IVE
1	EA	SFIC	OWNER PROVIDED	626	BES
1	EA	ENTRANCE LOCK	ND53BD SPA XN12-307	626	SCH
1	EA	COORDINATOR	COR X FL X MB AS REQ'D	628	IVE
1	EA	SURFACE CLOSER	4040XP HCUSH (RH LEAF)	689	LCN
1	EA	SURFACE CLOSER	4040XP HEDA (LH LEAF)	689	LCN
2	EA	ARMOR PLATE	8402 34" X 1" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	626	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	ASTRAGAL	FMA LEAD LINED ASTRAGAL	600	ANE

HARDWARE SET: 09A
FOR USE ON DOOR #(S):
T1367A
PROVIDE EACH PR DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	PIVOT SET	7226F SET	630	IVE
2	EA	INTERMEDIATE PIVOT	7226F INT	630	IVE
1	EA	AUTO FLUSH BOLT	FB31T	630	IVE
1	EA	SFIC	OWNER PROVIDED	626	BES
1	EA	ENTRANCE LOCK	ND53BD SPA XN12-307	626	SCH
1	EA	COORDINATOR	COR X FL X MB AS REQ'D	628	IVE
1	EA	SURFACE CLOSER	4040XP HCUSH (RH LEAF)	689	LCN
1	EA	SURFACE CLOSER	4040XP HEDA (LH LEAF)	689	LCN
2	EA	ARMOR PLATE	8402 34" X 1" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	626	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	ASTRAGAL	FMA LEAD LINED ASTRAGAL	600	ANE

HARDWARE SET: 09B
FOR USE ON DOOR #(S):
T1370A T1372
PROVIDE EACH PR DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	PIVOT SET	7226F SET	630	IVE
2	EA	INTERMEDIATE PIVOT	7226F INT	630	IVE
1	EA	AUTO FLUSH BOLT	FB31T	630	IVE
1	EA	SFIC	OWNER PROVIDED	626	BES
1	EA	ENTRANCE LOCK	ND53BD SPA XN12-307	626	SCH
1	EA	COORDINATOR	COR X FL X MB AS REQ'D	628	IVE
2	EA	SURFACE CLOSER	4040XP HEDA	689	LCN
2	EA	ARMOR PLATE	8402 34" X 1" LDW B-CS	630	IVE
2	EA	WALL STOP	WS406/407CCV	626	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	ASTRAGAL	FMA LEAD LINED ASTRAGAL	600	ANE

HARDWARE SET: 10
FOR USE ON DOOR #(S):
T1013A T1259
PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW X SIZE AS REQ'D	652	IVE
1	EA	PASSAGE SET	ND10S SPA	626	SCH
1	EA	WALL STOP	WS406/407CCV	626	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

HARDWARE SET: 11
FOR USE ON DOOR #(S):
T1374A
PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW X SIZE AS REQ'D	652	IVE
1	EA	PRIV W/DB COIN TURN	L9444 17A L583-363 L283-722	626	SCH
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	626	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

HARDWARE SET: 12
FOR USE ON DOOR #(S):
T1375
PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW X SIZE AS REQ'D	652	IVE
1	EA	PRIV W/DB COIN TURN	L9444 17A L583-363 L283-722	626	SCH
1	EA	OH STOP	90S	630	GLY
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

HARDWARE SET: 13
FOR USE ON DOOR #(S):
T1372B
PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	224XY	628	IVE
1	EA	PRIV W/DB COIN TURN	L9444 17A L583-363 L283-722 XL11-515	626	SCH
1	EA	WALL STOP	WS406/407CCV	626	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

HARDWARE SET: 14
FOR USE ON DOOR #(S):
T1367B T1370B
PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONT. HINGE	224XY	628	IVE
1	EA	PASSAGE SET	ND10S SPA XN12-307	626	SCH
1	EA	OH STOP	90S	630	GLY
1	EA	GASKETING	488SBK PSA	BK	ZER

HARDWARE SET: 15
FOR USE ON DOOR #(S):
TC1306A
PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW X SIZE AS REQ'D	652	IVE
1	EA	PASSAGE SET	ND10S SPA	626	SCH
1	EA	SURFACE CLOSER	4040XP REG OR PA AS REQ	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	626	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

HARDWARE SET: 16
FOR USE ON DOOR #(S):
T1374
PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW X SIZE AS REQ'D	652	IVE
1	EA	PASSAGE SET	ND10S SPA	626	SCH
1	EA	SURFACE CLOSER	4011 DEL	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CCV	626	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

HARDWARE SET: 17 - Not Used

HARDWARE SET: 18
FOR USE ON DOOR #(S):
T1381
PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY	DESCRIPTION	CATALOG NUMBER	FINISH	MFR

NOTE: ALL HARDWARE BY DOOR SYSTEM MANUFACTURER

END OF SECTION 08 71 11

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SECTION 08 71 13 – AUTOMATIC DOOR OPERATORS

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. Low-energy door operators for swinging doors.

1.03 REFERENCED STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
B. American Architectural Manufacturers Association:
   1. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum.
C. ASTM International:
   1. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   2. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
   3. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
   4. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric).
D. Builders Hardware Manufacturers Association:
   1. ANSI/BHMA A156.19 - Power Assist and Low Energy Power Operated Doors.
E. National Fire Protection Association:
   1. NFPA 70 - National Electrical Code.
F. Underwriters Laboratories Inc.:
   1. UL 325 - Door, Drapery, Gate, Louver, and Window Operators and Systems.

1.04 DEFINITIONS:

A. AAADM: American Association of Automatic Door Manufacturers.
B. Activation Device: A control that, when actuated, sends an electrical signal to the door operator to open the door.
C. Double-Egress (Doors): A pair of doors that simultaneously swing, with the two doors moving in opposite directions with no mullion between them.
D. Safety Device: A control that, to avoid injury, prevents a door from opening or closing.
E. For automatic door terminology, see ANSI/BHMA A156.19 for definitions of terms.

1.05 COORDINATION:

A. Templates: Distribute for doors, frames, and other work specified to be factory prepared and reinforced for installing automatic door operators.
B. Coordinate hardware for doors with operators to ensure proper size, thickness, hand, function, and finish.
C. Electrical System Roughing-in: Coordinate layout and installation of automatic door operators with connections to the following:

1. Power supplies.
2. Access-control system.
3. Remote activation devices.
4. Remote monitoring systems.

1.06 PREINSTALLATION MEETINGS:

A. Preinstallation Conference: Conduct conference at Project site.

1.07 SUBMITTALS:

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for automatic door operators.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
B. Shop Drawings: For automatic door operators.
   1. Include plans, elevations, sections, hardware mounting heights, and attachment details.
   2. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Indicate locations of activation and safety devices.
   4. Include diagrams for power, signal, and control wiring.
C. Product Certificates: For each type of automatic door operator. For each operator for fire-rated door assemblies, certify that operator is listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for use on types and sizes of labeled fire doors required.
D. Sample Warranties: For manufacturer's special warranties.
E. Maintenance Data: For automatic door operators, safety devices, and control systems, to include in maintenance manuals.

1.08 QUALITY ASSURANCE:

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer for installation and maintenance of units required for this Project.
   1. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.

1.09 WARRANTY:

A. Special Warranty: Manufacturer agrees to repair or replace components of automatic door operators that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Faulty or sporadic operation of automatic door operator, including controls.
      b. Deterioration of metals, metal finishes, and other materials beyond normal weathering or use.
   2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Basis-of-Design Product; Surface Mounted Operator: Subject to compliance with requirements, provide Besam Entrance Solutions; ASSA ABLOY; SW200i or comparable product by one of the following:
   1. Detex Corporation.
   2. Horton Automatics; a division of Overhead Door Corporation.
   3. LCN; an Allegion brand.
   4. Norton Door Controls; an ASSA ABLOY Group company.
   5. record-usa.
   6. Stanley Access Technologies.

B. Basis-of-Design Product; Overhead Concealed Operator: Subject to compliance with requirements, provide Besam Entrance Solutions; ASSA ABLOY; SW200i-OHC or comparable product by one of the following:
   1. Detex Corporation.
   2. Horton Automatics; a division of Overhead Door Corporation.
   3. LCN; an Allegion brand.
   4. Norton Door Controls; an ASSA ABLOY Group company.
   5. record-usa.
   6. Stanley Access Technologies.

C. Source Limitations: Obtain automatic door operators, including activation and safety devices, from single source from single manufacturer.

2.02 AUTOMATIC DOOR OPERATORS, GENERAL:

A. General: Provide operators of size recommended by manufacturer for door size, weight, and movement; for condition of exposure; and for long-term, maintenance-free operation under normal traffic load for occupancy type indicated; and in accordance with UL 325. Coordinate operator mechanisms with door operation, hinges, and activation and safety devices.
   1. Fire-Rated Doors: Provide door operators for fire-rated door assemblies that comply with NFPA 80 for fire-rated door components and are listed and labeled by a qualified testing agency.

B. Electromechanical Operating System: Self-contained unit powered by permanent-magnet dc motor; with closing speed controlled mechanically by gear train and dynamically by braking action of electric motor, connections for power and activation- and safety-device wiring, and manual operation, including spring closing when power is off.

C. Hinges: See SECTION 08 71 11 "DOOR HARDWARE (DESCRIPTIVE SPECIFICATION)" for hinge type for each door that door operator shall accommodate.

D. Cover for Surface-Mounted Operators: Fabricated from 0.125-inch- (3.2-mm-) thick, extruded or formed aluminum; continuous over full width of door opening, including door jambs; with enclosed end caps, provision for maintenance access, and fasteners concealed when door is in closed position.

E. Brackets and Reinforcements: Fabricated from aluminum with nonstaining, nonferrous shims for aligning system components.

F. Fire-Door Package: Consisting of UL-listed latch mechanism, power-reset box, and caution signage for fire-rated doors. Latch mechanism shall allow door to swing free during automatic operation; when fire is detected, latch actuator shall cause exit hardware to latch when door closes. Provide latch actuators with fail-secure design.

G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.03 LOW-ENERGY DOOR OPERATORS FOR SWINGING DOORS:

A. Standard: ANSI/BHMA A156.19.

B. Performance Requirements:

1. Opening Force if Power Fails: Not more than 15 lbf (67 N) required to release latch if provided, not more than 30 lbf (133 N) required to manually set door in motion, and not more than 15 lbf (67 N) required to fully open door.
2. Entrapment-Prevention Force: Not more than 15 lbf (67 N) required to prevent stopped door from closing or opening.

C. Configuration: Operator to control single swinging door.

1. Traffic Pattern: Two way.
2. Operator Mounting: Surface.

D. Configuration: Operator to control pair of swinging doors.

1. Traffic Pattern: Two wayDouble egress.
2. Pairs of Doors: Simultaneous swing.
3. Operator Mounting: Surface or overhead concealed as indicated.

E. Operation: Power opening and spring closing. Provide time delay for door to remain open before initiating closing cycle as required by ANSI/BHMA A156.19. When not in automatic mode, door operator shall function as manual door closer, with or without electrical power.

F. Operating System: Electromechanical.

G. Microprocessor Control Unit: Solid-state controller.

H. Features:

1. Adjustable opening and closing speed.
2. Adjustable opening and closing force.
3. Adjustable backcheck.
4. Adjustable hold-open time from zero to 30 seconds.
5. Adjustable time delay.
6. Adjustable acceleration.
7. Obstruction recycle.
8. On-off/hold-open switch to control electric power to operator.

I. Activation Device: Touchless switch on each side of door to activate door operator.

J. Exposed Finish: Class I, clear anodic finish.

2.04 MATERIALS:

A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.

1. Extrusions: ASTM B221 (ASTM B221M).
2. Sheet: ASTM B209 (ASTM B209M).

B. Fasteners and Accessories: Corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

2.05 CONTROLS:

A. General: Provide controls, including activation and safety devices, in accordance with BHMA standards; for condition of exposure; and for long-term, maintenance-free operation under normal traffic load for occupancy type indicated. Coordinate activation and safety devices with door operation and door operator mechanisms.

B. Presence Sensors: Self-contained, active-infrared scanner units; adjustable to provide detection field sizes and functions required by ANSI/BHMA A156.10. Sensors shall remain active at all times.
C. Touchless Switch: Hands-free activation door-control switch with flat motion sensor face-plate with contrasting-colored, engraved message.
   1. Configuration: 4.56-by-4.56-inch (115.8-by-115.8-mm) (double gang) square face plate.
      a. Mounting: Recess mounted in wall.
   2. Face-Plate Material: Stainless steel.
   3. Message: International symbol of accessibility and "Wave to Open" and wave symbol.

2.06 ACCESSORIES:
A. Signage: As required by cited BHMA standard for type of door and its operation.
   1. Application Process: Decals.
   2. Provide sign materials with instructions for field application when operators are installed.

2.07 FABRICATION:
A. Factory fabricate automatic door operators to comply with indicated standards.
B. Form aluminum shapes before finishing.
C. Fabricate exterior components to drain condensation and water-passing joints within operator enclosure to the exterior.
D. Use concealed fasteners to greatest extent possible. Where exposed fasteners are required, use countersunk Phillips flat-head machine screws, finished to match operator.

2.08 GENERAL FINISH REQUIREMENTS:
A. Protect mechanical finishes on exposed surfaces from damage by applying strippable, temporary, protective covering before shipping.
B. Apply organic and anodic finishes to formed metal after fabrication unless otherwise indicated.
C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within range of approved Samples and are assembled or installed to minimize contrast.

2.09 ALUMINUM FINISHES:
A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

PART 3 - EXECUTION

3.01 EXAMINATION:
A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances, door and frame preparation and reinforcements, and other conditions affecting performance of automatic door operators.
B. Examine roughing-in for electrical systems to verify actual locations of power connections before automatic door operator installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL:
A. Install automatic door operators in accordance with manufacturer's written instructions and cited BHMA standard for type of door operation and direction of pedestrian travel, including signage, controls, wiring, remote power units if any, and connection to building's power supply.

1. Do not install damaged components. Fit joints to produce hairline joints free of burrs and distortion.
2. Install operators true in alignment with established lines and door geometry without warp or rack. Anchor securely in place.

B. Controls: Install activation and safety devices in accordance with manufacturer's written instructions and cited BHMA standard for operator type and direction of pedestrian travel. Connect control wiring in accordance with SECTION 26 05 19 "LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES."

C. Access-Control System: Connect operators to access-control system as specified in SECTION 28 15 00 "ACCESS CONTROL HARDWARE DEVICES."

D. Signage: Apply on both sides of each door as required by cited BHMA standard for type of door operator and direction of pedestrian travel.

3.03 FIELD QUALITY CONTROL:

A. Certified Inspector: Owner will engage a Certified Inspector to test and inspect components, assemblies, and installations, including connections.

3.04 ADJUSTING:

A. Adjust automatic door operators to function smoothly, and lubricate as recommended by manufacturer; comply with requirements of applicable BHMA standards.

B. After completing installation of automatic door operators, inspect exposed finishes on doors and operators. Repair damaged finish to match original finish.

C. Readjust automatic door operators and controls after repeated operation of completed installation equivalent to three days' use by normal traffic (100 to 300 cycles).

D. Occupancy Adjustment: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.05 DEMONSTRATION:

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain automatic door operators.

END OF SECTION 08 71 13

SECTION 08 80 00 – GLAZING

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. Glass for windows, doors, and interior borrowed lites.

1.03 RELATED REQUIREMENTS:

A. SECTION 08 88 13 "FIRE-RESISTANT GLAZING."

1.04 REFERENCED STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
B. American Society of Civil Engineers/Structural Engineering Institute:
   1. ASCE/SEI 7 - Minimum Design Loads for Buildings and Other Structures.
C. ASTM International:
   1. ASTM C 1036 - Specification for Flat Glass.
   2. ASTM C 1048 - Specification for Heat-Strengthened and Fully Tempered Flat Glass.
   3. ASTM C 1172 - Specification for Laminated Architectural Flat Glass.
   4. ASTM E 1300 - Practice for Determining Load Resistance of Glass in Buildings.
   5. ASTM E 2190 - Specification for Insulating Glass Unit Performance and Evaluation.
D. Code of Federal Regulations:
   1. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials.
E. Glass Association of North America:
   1. Engineering Standards Manual.
   2. Glazing Manual.
F. Insulating Glass Manufacturers Alliance:
   1. IGMA TM-3000 - North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use.
G. International Code Council:
   1. International Building Code.
H. Lawrence Berkeley National Laboratory; Environmental Energy Technologies Division; Building Technologies Department; Windows & Daylighting Group:
   1. WINDOW - A Computer Program for Calculating Total Window Thermal Performance Indices.
I. National Fenestration Rating Council:
   1. ANSI/NFRC 100 - Procedure for Determining Fenestration Product U-Factors.
   2. ANSI/NFRC 200 - Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence.
   3. NFRC 300 - Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems.

1.05 DEFINITIONS:

A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C1036.
C. IBC: International Building Code.
D. Interspace: Space between lites of an insulating-glass unit.

1.06 COORDINATION:
A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.07 PREINSTALLATION MEETINGS:
A. Preinstallation Conference: Conduct conference at Project site.
1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review temporary protection requirements for glazing during and after installation.

1.08 SUBMITTALS:
A. Product Data: For each type of product.
B. Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches (300 mm) square.
C. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.
D. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
E. Qualification Data: For manufacturers of insulating-glass units with sputter-coated, low-E coatings.
F. Product Certificates: For glass.
G. Product Test Reports: For coated glass and insulating glass, for tests performed by a qualified testing agency.
H. Preconstruction adhesion and compatibility test report.
I. Sample Warranties: For special warranties.

1.09 QUALITY ASSURANCE:
A. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved and certified by coated-glass manufacturer.
B. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
C. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.
D. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.
1. Install glazing in mockups specified in SECTION 08 44 13 "GLAZED ALUMINUM CURTAIN WALLS" to match glazing systems required for Project, including glazing methods.

1.10 DELIVERY, STORAGE, AND HANDLING:

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

1.11 FIELD 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.

1.12 WARRANTY:

A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.
   1. Warranty Period: 10 years from date of Substantial Completion.

B. Manufacturer's Special Warranty for Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
   1. Warranty Period: 10 years from date of Substantial Completion.

C. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
   1. Warranty Period: 10 years from date of Substantial Completion.

D. Manufacturer's Special Warranty for Tempered Glass: Manufacturer agrees to replace tempered glass units that break spontaneously as a result of Nickel Sulfide (NiS) inclusions within specified warranty period.
   1. Warranty Period: 10 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. Guardian Glass; SunGuard.
   2. Oldcastle BuildingEnvelope™.
   3. Pilkington North America.
   4. Vetrotech Saint-Gobain.
   5. Viracon, Inc.
   6. Vitro Architectural Glass.

B. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.
   1. Obtain tinted glass from single source from single manufacturer.
   2. Obtain reflective-coated glass from single source from single manufacturer.

C. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

2.02 PERFORMANCE REQUIREMENTS:

A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Delegated Design: Engage a qualified professional engineer to design glazing.

C. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the IBC and ASTM E1300.
   1. Design Wind Pressures: As indicated on Drawings.
   2. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch (25 mm), whichever is less.
   3. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.

D. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

E. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
   1. For monolithic-glass lites, properties are based on units with lites 6 mm thick.
   2. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
   3. U-Factors: Center-of-glazing values, according to ANSI/NFRC 100 and based on LBL's WINDOW computer program, expressed as Btu/sq. ft. x h x deg F (W/sq. m x K).
   4. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to ANSI/NFRC 200 and based on LBL's WINDOW computer program.
   5. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.03 GLASS PRODUCTS, GENERAL:

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this SECTION or in referenced standards.
   1. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."

B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.

D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.
E. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.04 GLASS PRODUCTS:

A. Low-Iron Float Glass: ASTM C1036, Type I, Class I (clear), Quality-Q3.
B. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
   1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
C. Heat-Strengthened Float Glass: ASTM C1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
   1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
D. Ceramic-Coated Spandrel Glass: ASTM C1048, Type I, Condition B, Quality-Q3.

2.05 LAMINATED GLASS:

A. Laminated Glass: ASTM C1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
   1. Construction: Laminate glass with polyvinyl butyral interlayer to comply with interlayer manufacturer's written instructions.
   2. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
   3. Interlayer Color: Clear unless otherwise indicated.

2.06 INSULATING GLASS:

A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E2190.
   1. Sealing System: Dual seal, with manufacturer's standard primary and secondary sealants.
   2. Perimeter Spacer: Rigid plastic warm edge spacer with integral stainless steel wires.
      a. Manufacturers: Subject to compliance with requirements, provide one of the following:
         (1) Technoform Glass Insulation NA, Inc.; TGI-Spacer M.
         (2) Thermix; a brand of Ensinger USA; Thermix TX Pro.
      b. Color: Black.
   3. Desiccant: Molecular sieve or silica gel, or a blend of both.

2.07 MISCELLANEOUS GLAZING MATERIALS:

A. General: Provide products of material, size, and shape complying with referenced glazing standard, with requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks:
   1. Type recommended by sealant or glass manufacturer.
D. Spacers:
   1. Type recommended by sealant or glass manufacturer.
E. Edge Blocks:
   1. Type recommended by sealant or glass manufacturer.

2.08 FABRICATION OF GLAZING UNITS:

A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
   1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
      a. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.
C. Grind smooth and polish exposed glass edges and corners.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
   1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
   2. Presence and functioning of weep systems.
   3. Minimum required face and edge clearances.
   4. Effective sealing between joints of glass-framing members.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

3.03 GLAZING, GENERAL:

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.

C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
F. Provide spacers for glass lites where length plus width is larger than 50 inches (1270 mm).
    1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
    2. Provide 1/8-inch (3-mm) minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
I. Set glass lites with proper orientation so that coatings face exterior or interior as specified.
J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.04 GASKET GLAZING (DRY):

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
E. Install gaskets so they protrude past face of glazing stops.

3.05 SEALANT GLAZING (WET):

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.06 CLEANING AND PROTECTION:

A. Immediately after installation remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.

1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.

C. Remove and replace glass that is damaged during construction period.

D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

3.07 MONOLITHIC GLASS SCHEDULE:

A. Glass Type **GL-1**: Clear fully tempered float glass.

1. Minimum Thickness: 6 mm.
2. Safety glazing required.

B. Glass Type **GL-2**: Clear fully tempered float glass, fire rated.

1. Minimum Thickness: 6 mm.
2. Safety glazing required.
3. Refer to door and window schedules for required fire ratings.

C. Glass Type **GL-6**: Clear fully tempered float glass, lead lined.

1. Minimum Thickness: 10 mm.
2. Safety glazing required.
3. Refer to door and physicists report drawings for required ratings.

END OF SECTION 08 80 00

SECTION 08 88 13 – FIRE-RESISTANT GLAZING

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-protection-rated glazing.
   2. Fire-resistance-rated glazing.

1.03 REFERENCED STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
B. American Architectural Manufacturers Association:
   1. AAMA 800 - Voluntary Specifications and Test Methods for Sealants.
C. ASTM International:
   1. ASTM C 920 - Specification for Elastomeric Joint Sealants.
   2. ASTM C 1036 - Specification for Flat Glass.
   3. ASTM C 1048 - Specification for Heat-Strengthened and Fully Tempered Flat Glass.
   4. ASTM C 1281 - Specification for Preformed Tape Sealants for Glazing Applications.
   5. ASTM E 119 - Test Methods for Fire Tests of Building Construction and Materials.
D. Code of Federal Regulations:
   1. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials.
E. Glass Association of North America:
   1. Glazing Manual.
   2. Laminated Glazing Reference Manual.
F. National Fire Protection Association:
   1. NFPA 80 - Fire Doors and Other Opening Protectives.
   2. NFPA 252 - Fire Tests of Door Assemblies.
G. Underwriters Laboratories Inc.:
   1. UL 9 - Fire Tests of Window Assemblies.
   2. UL 263 - Fire Tests of Building Construction and Materials.

1.04 DEFINITIONS:

A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.

1.05 COORDINATION:

A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.06 SUBMITTALS:

A. Product Data: For each type of product.
B. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

C. Glass Samples: For each type of glass product; 12 inches (300 mm) square.
D. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.
E. Product Certificates: For each type of glass and glazing product, from manufacturer.
F. Sample Warranties: For special warranties.

1.07 QUALITY ASSURANCE:

A. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

1.08 DELIVERY, STORAGE, AND HANDLING:

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

1.09 FIELD CONDITIONS:

A. Environmental Limitations: Do not deliver or install fire-resistant glazing until spaces are enclosed and weathertight and temporary HVAC system is operating and maintaining ambient temperature conditions at occupancy levels during the remainder of the construction period.

1.10 WARRANTY:

A. Manufacturer's Special Warranty on Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
   1. Warranty Period: 10 years from date of Substantial Completion.
B. Manufacturer's Special Warranty on Double Glazing Units with Clear Gel Fill: Manufacturer agrees to replace units that deteriorate within specified warranty period. Deterioration of double glazing units with clear gel fill is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning glass contrary to manufacturer's written instructions. Evidence of failure is the leakage of gel fill from units, air bubbles within units, or obstruction of vision by contamination or deterioration of gel.
   1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.
B. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

2.02 PERFORMANCE REQUIREMENTS:

A. General: Installed glazing systems shall withstand normal thermal movement and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; deterioration of glazing materials; or other defects in construction.

2.03 GLASS PRODUCTS, GENERAL:

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organization below unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this SECTION or in referenced standards.
   1. GANA Publications: "Glazing Manual."

B. Safety Glazing Labeling: Permanently mark glazing with certification label of the Safety Glazing Certification Council or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, glass thickness, and safety glazing standard with which glass complies.

2.04 GLASS PRODUCTS:

A. Tempered Float Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class I (clear) unless otherwise indicated, Quality-Q3.
   1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

2.05 FIRE-PROTECTION-RATED GLAZING:

A. Fire-Protection-Rated Glazing: Listed and labeled by a testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on positive-pressure testing according to NFPA 257 or UL 9, including the hose-stream test, and shall comply with NFPA 80.

B. Fire-Protection-Rated Glazing Labeling: Permanently mark fire-protection-rated glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name; test standard; whether glazing is permitted to be used in doors or openings; if permitted in openings, whether or not glazing has passed the hose-stream test; whether or not glazing meets 450 deg F (250 deg C) temperature-rise limitation; and the fire-resistance rating in minutes.

C. Laminated Ceramic Glazing: Laminated glass made from two plies of clear, ceramic glass; 8-mm total thickness; and complying with 16 CFR 1201, Category II.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. AGC Glass Company North America, Inc.
      b. SAFTI FIRST Fire Rated Glazing Solutions.
      c. Schott North America, Inc.
      d. Technical Glass Products.
      e. Vetrotech Saint-Gobain.

2.06 FIRE-RESISTANCE-RATED GLAZING:

A. Fire-Resistance-Rated Glazing: Listed and labeled by a testing agency acceptable to authorities having jurisdiction, for fire-resistance ratings indicated, based on testing according to ASTM E 119 or UL 263.

B. Fire-Resistance-Rated Glazing Labeling: Permanently mark fire-resistance-rated glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall

indicate manufacturer's name, test standard, that the glazing is approved for use in walls, and the fire-resistance rating in minutes.

C. Laminated Glass with Intumescent Interlayers: Laminated glass made from multiple plies of uncoated, ultraclear float glass; with intumescent interlayers; and complying with 16 CFR 1201, Category II.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. AGC Glass Company North America, Inc.
      b. Pilkington North America.
      c. SAFTI FIRST Fire Rated Glazing Solutions.
      d. Technical Glass Products.
      e. Vetrotech Saint-Gobain.

2.07 GLAZING ACCESSORIES:

A. Provide glazing gaskets, glazing sealants, glazing tapes, setting blocks, spacers, edge blocks, and other glazing accessories that are compatible with glazing products and each other and are approved by testing agencies that listed and labeled fire-resistant glazing products with which products are used for applications and fire-protection ratings indicated.

B. Glazing Sealants for Fire-Rated Glazing Products: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 50, Use NT. Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Dow Corning Corporation.
      b. GE Construction Sealants; Momentive Performance Materials Inc.
      c. Tremco Incorporated.
   2. Sealant shall have a VOC content of 250 g/L or less.
   3. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
   4. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.

C. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
   1. AAMA 804.3 tape, where indicated.
   2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
   3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

D. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
   1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
   2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.08 MISCELLANEOUS GLAZING MATERIALS:

A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Perimeter Insulation for Fire-Resistive Glazing: Product that is approved by testing agency that listed and labeled fire-resistant glazing product with which it is used for application and fire-protection rating indicated.

2.09 FABRICATION OF GLAZING UNITS:

A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine framing, glazing channels, and stops, with Installer present, for compliance with manufacturing and installation tolerances, including those for size, squareness, and offsets at corners, and for compliance with minimum required face and edge clearances.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

B. Examine glazing units to locate fire side and protected side. Label or mark units as needed so that fire side and protected side are readily identifiable. Do not use materials that leave visible marks in the completed work.

3.03 GLAZING, GENERAL:

A. Use methods approved by testing agencies that listed and labeled fire-resistant glazing products.

B. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials unless more stringent requirements are indicated, including those in referenced glazing publications.

C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

G. Provide spacers for glass lites where length plus width is larger than 50 inches (1270 mm).

1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances unless gaskets and glazing

tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.

2. Provide 1/8-inch (3-mm) minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

I. Set glass lites with proper orientation so that coatings face fire side or protected side as specified.

J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.04 TAPE GLAZING:

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Do not remove release paper from tape until right before each glazing unit is installed.

F. Apply heel bead of elastomeric sealant.

G. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.05 GASKET GLAZING (DRY):

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop, so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

D. Install gaskets so they protrude past face of glazing stops.

3.06 SEALANT GLAZING (WET):

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
C. Tool exposed surfaces of sealants to provide a substantial washaway from glass.

3.07 CLEANING AND PROTECTION:

A. Immediately after installation, remove nonpermanent labels and clean surfaces.
B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
    1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.
C. Remove and replace glass that is damaged during construction period.
D. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

3.08 FIRE-PROTECTION-RATED GLAZING SCHEDULE:

A. Glass Type : 45-minute and 90-minute fire-protection-rated glazing; laminated ceramic glazing.

END OF SECTION 08 88 13

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SECTION 09 21 16.23 – GYPSUM BOARD SHAFT WALL ASSEMBLIES

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 gypsum board shaft wall assemblies.

1.03 REFERENCED STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. ASTM International:

1. ASTM A 653/A 653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
2. ASTM C 645 - Specification for Nonstructural Steel Framing Members.
3. ASTM C 840 - Specification for Application and Finishing of Gypsum Board.
4. ASTM C 1002 - Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
5. ASTM C 1396/C 1396M - Specification for Gypsum Board.
6. ASTM D 3273 - Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
7. ASTM D 3274 - Test Method for Evaluating Degree of Surface Disfigurement of Paint Films by Fungal or Algal Growth, or Soil and Dirt Accumulation.
8. ASTM E 90 - Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
9. ASTM E 119 - Test Methods for Fire Tests of Building Construction and Materials.
10. ASTM E 413 - Classification for Rating Sound Insulation.
11. ASTM E 488/E 488M - Test Methods for Strength of Anchors in Concrete Elements.
12. ASTM E 1190 - Test Methods for Strength of Power-Actuated Fasteners Installed in Structural Members.

C. ICC Evaluation Service, LLC:

1. ICC-ES AC70 - Fasteners Power-Driven into Concrete, Steel and Masonry Elements.
2. ICC-ES AC193 - Mechanical Anchors in Concrete Elements.

1.04 SUBMITTALS:

A. Product Data: For each component of gypsum board shaft wall assembly.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.

1.05 DELIVERY, STORAGE, AND HANDLING:

A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and support them on risers on a flat platform to prevent sagging.

1.06 FIELD CONDITIONS:

A. Environmental Limitations: Comply with gypsum-shaftliner-board manufacturer's written instructions.
B. Do not install finish panels until installation areas are enclosed and conditioned.
C. Do not install panels that are wet, moisture damaged, or mold damaged.
   1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
   2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
B. STC-Rated Assemblies: Provide materials and construction identical to those of assemblies tested according to ASTM E 90 and classified according to ASTM E 413 by a testing and inspecting agency.

2.02 GYPSUM BOARD SHAFT WALL ASSEMBLIES:

A. Fire-Resistance Rating: As indicated.
B. STC Rating: As indicated.
C. Gypsum Shaftliner Board:
   1. Moisture- and Mold-Resistant Type X: ASTM C 1396/C 1396M; manufacturer's proprietary fire-resistive liner panels with ASTM D 3273 mold-resistance score of 10 as rated according to ASTM D 3274, 1 inch (25.4 mm) thick, and with double beveled long edges.
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         (1) American Gypsum.
         (2) CertainTeed Corporation.
         (3) Georgia-Pacific Gypsum LLC.
         (4) National Gypsum Company.
         (5) USG Corporation.
D. Non-Load-Bearing Steel Framing, General: Complying with ASTM C 645 requirements for metal unless otherwise indicated and complying with requirements for fire-resistance-rated assembly indicated.
   1. Protective Coating: Coating with equivalent corrosion resistance of ASTM A 653/A 653M, G40 (Z120) unless otherwise indicated.
E. Studs: Manufacturer's standard profile for repetitive, corner, and end members as follows:
   1. Depth: As indicated.

2. Minimum Base-Metal Thickness: 0.018 inch (0.45 mm). Minimum of 20 gauge.

F. Runner Tracks: Manufacturer's standard J-profile track with manufacturer's standard long-leg length, but at least 2 inches (51 mm) long and matching studs in depth.
   1. Minimum Base-Metal Thickness: Matching steel studs.

G. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Blazeframe Industries.
      b. CEMCO; California Expanded Metal Products Co.
      c. Fire Trak Corp.
      d. Grace Construction Products; W.R. Grace & Co. -- Conn.
      e. Steel Network, Inc. (The).

H. Elevator-Hoistway-Entrance Struts: Manufacturer's standard J-profile jamb strut with long-leg length of 3 inches (76 mm), matching studs in depth, and not less than 0.033 inch (0.84 mm) thick.

I. Finish Panels: Gypsum board as specified in SECTION 09 29 00 "GYPSUM BOARD."

J. Sound Attenuation Blankets: As specified in SECTION 09 29 00 "GYPSUM BOARD."

2.03 AUXILIARY MATERIALS:

A. General: Provide auxiliary materials that comply with shaft wall manufacturer's written instructions.

B. Trim Accessories: Cornerbead, edge trim, and control joints of material and shapes as specified in SECTION 09 29 00 "GYPSUM BOARD" that comply with gypsum board shaft wall assembly manufacturer's written instructions for application indicated.

C. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.

D. Track Fasteners: Power-driven fasteners of size and material required to withstand loading conditions imposed on shaft wall assemblies without exceeding allowable design stress of track, fasteners, or structural substrates in which anchors are embedded.
   1. Expansion Anchors: Fabricated from corrosion-resistant materials, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing per ASTM E 488/E 488M conducted by a qualified testing agency.
   2. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E 1190 conducted by a qualified testing agency.

E. Reinforcing: Galvanized-steel reinforcing strips with 0.033-inch (0.84-mm) minimum thickness of base metal (uncoated).

F. Acoustical Sealant: SECTION 07 92 19 "ACOUSTICAL JOINT SEALANTS."

G. Gypsum Board Cants:
   1. Gypsum Board Panels: As specified in SECTION 09 29 00 "GYPSUM BOARD," Type X, 1/2- or 5/8-inch (13- or 16-mm) panels.
   2. Adhesive: Laminating adhesive as specified in SECTION 09 29 00 "GYPSUM BOARD."

3. Non-Load-Bearing Steel Framing: As specified in SECTION 09 22 16 "NON-STRUCTURAL METAL FRAMING."

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, or mold damaged.

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

3.02 PREPARATION:

A. Sprayed Fire-Resistive Materials: Coordinate with gypsum board shaft wall assemblies so both elements of Work remain complete and undamaged. Patch or replace sprayed fire-resistive materials removed or damaged during installation of shaft wall assemblies to comply with requirements specified in SECTION 07 81 00 "APPLIED FIREPROOFING."

B. After sprayed fire-resistive materials are applied, remove only to extent necessary for installation of gypsum board shaft wall assemblies and without reducing the fire-resistive material thickness below that which is required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

3.03 INSTALLATION:

A. General: Install gypsum board shaft wall assemblies to comply with requirements of fire-resistance-rated assemblies indicated and manufacturer's written installation instructions.

B. Do not bridge building expansion joints with shaft wall assemblies; frame both sides of expansion joints with furring and other support.

C. Install supplementary framing in gypsum board shaft wall assemblies around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings, wall-mounted door stops, and similar items that cannot be supported directly by shaft wall assembly framing.

1. Elevator Hoistway: At elevator hoistway-entrance door frames, provide jamb struts on each side of door frame.
2. Reinforcing: Provide where items attach directly to shaft wall assembly as indicated on Drawings; accurately position and secure behind at least one layer of face panel.

D. Penetrations: At penetrations in shaft wall, maintain fire-resistance rating of shaft wall assembly by installing supplementary steel framing around perimeter of penetration and fire protection behind boxes containing wiring devices, elevator call buttons and floor indicators, and similar items.

E. Isolate perimeter of gypsum panels from building structure to prevent cracking of panels while maintaining continuity of fire-rated construction.

F. Firestop Tracks: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.

G. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect while maintaining fire-resistance rating of gypsum board shaft wall assemblies.

H. Sound-Rated Shaft Wall Assemblies: Seal gypsum board shaft walls with acoustical sealant at perimeter of each assembly where it abuts other work and at joints and penetrations within each assembly.

I. Gypsum Board Cants: At projections into shaft exceeding 4 inches (102 mm), install gypsum board cants covering tops of projections.
   1. Slope cant panels at least 75 degrees from horizontal. Set base edge of panels in adhesive and secure top edges to shaft walls at 24 inches (610 mm) o.c. with screws fastened to shaft wall framing.
   2. Where non-load-bearing steel framing is required to support gypsum board cants, install framing at 24 inches (610 mm) o.c. and extend studs from the projection to shaft wall framing.

J. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.

3.04 PROTECTION:

A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

B. Remove and replace panels that are wet, moisture damaged, or mold damaged.
   1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
   2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 09 21 16.23

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SECTION 09 22 16 – NON-STRUCTURAL METAL FRAMING

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. Non-load-bearing steel framing systems for interior partitions.
   2. Suspension systems for interior ceilings and soffits.
   3. Grid suspension systems for gypsum board ceilings.

1.03 RELATED REQUIREMENTS:

A. SECTION 05 40 00 "COLD-FORMED METAL FRAMING" for exterior and interior load-bearing and exterior non-load-bearing wall studs; floor joists; and roof rafters and ceiling joists.

1.04 REFERENCED STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. American Iron and Steel Institute:
   1. AISI S220 - North American Standard for Cold-Formed Steel Framing - Nonstructural Members.

C. ASTM International:
   1. ASTM A 641/A 641M - Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
   2. ASTM A 653/A 653M -Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   3. ASTM B 633 - Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
   4. ASTM C 645 - Specification for Nonstructural Steel Framing Members.
   5. ASTM C 754 - Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.
   6. ASTM C 840 - Specification for Application and Finishing of Gypsum Board.
   7. ASTM E 90 - Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
   8. ASTM E 119 - Test Methods for Fire Tests of Building Construction and Materials.
   9. ASTM E 413 - Classification for Rating Sound Insulation.
   10. ASTM F 1941/F 1941M - Specification for Electrodeposited Coatings on Mechanical Fasteners, Inch and Metric.

D. ICC Evaluation Service, LLC:
   1. ICC-ES AC70 - Acceptance Criteria for Power-Actuated Fasteners Driven into Concrete, Steel and Masonry Elements.
   2. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements.
   3. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.

E. Steel Framing Industry Association:
   1. Code Compliance Certification Program for Cold-Formed Steel Structural and Non-Structural Framing Members.

1.05 SUBMITTALS:

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Product Certificates: For each type of code-compliance certification for studs and tracks.

D. Evaluation Reports: For embossed, high-strength steel studs and tracks, firestop tracks, post-installed anchors, and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.06 QUALITY ASSURANCE:

A. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Certified Steel Stud Association, the Steel Framing Industry Association, or the Steel Stud Manufacturers Association.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings, according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

C. Horizontal Deflection: For wall assemblies, limited to 1/240 of the wall height based on horizontal loading of 5 lbf/sq. ft. (239 Pa).

D. Design framing systems in accordance with AISI S220, except as otherwise shown or specified.

E. Design framing systems to accommodate deflection of primary building structure and construction tolerances and to withstand design loads with a maximum deflection of one inch.

2.02 FRAMING SYSTEMS:

A. Framing Members, General: Comply with ASTM C754 for conditions indicated.

1. Steel Sheet Components: Comply with ASTM C645 requirements for steel unless otherwise indicated.

2. Protective Coating: Coating with equivalent corrosion resistance of ASTM A653/A653M, G40 (Z120), hot-dip galvanized unless otherwise indicated.

B. Studs and Tracks: ASTM C645. Use either conventional steel studs and tracks or embossed, high-strength steel studs and tracks.

1. Steel Studs and Tracks:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

(1) ClarkDietrich.
(2) MarinoWARE.
(3) MBA Building Supplies.
(4) Phillips Manufacturing Co.
(5) Telling Industries.
(6) The Steel Network, Inc.

b. Minimum Base-Steel Thickness: As required by performance requirements for horizontal deflection.
c. Depth: As indicated on Drawings.

2. Embossed, High Strength Steel Studs and Tracks: Roll-formed and embossed with surface deformations to stiffen the framing members so that they are structurally comparable to conventional ASTM C645 steel studs and tracks.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      (1) ClarkDietrich.
      (2) MarinoWARE.
      (3) MBA Building Supplies.
      (4) Phillips Manufacturing Co.
      (5) Telling Industries.
      (6) The Steel Network, Inc.
   b. Minimum Base-Steel Thickness: As required by horizontal deflection performance requirements. Minimum 20 gauge
   c. Depth: As indicated on Drawings.

C. Slip-Type Head Joints: Where indicated, provide the following:
   1. Slotted Deflection Track: Steel sheet slotted top track manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.

D. Firestop Tracks: Top track manufactured to allow partition heads to expand and contract with movement of structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.

E. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
   1. Minimum Base-Steel Thickness: As indicated on Drawings.

F. Cold-Rolled Channel Bridging: Steel, 0.0538-inch (1.367-mm) minimum base-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges.

G. Hat-Shaped, Rigid Furring Channels: ASTM C645.

H. Radius Framing: Steel sheet runner for non-load-bearing curves, bends, carriable radii, and arches.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide ClarkDietrich; 360TRAK or approved equal.
   2. Minimum Base-Steel Thickness: .0296-inch
   3. Depth: As indicated on Drawings.

I. Partial Wall Framing Connection: 1/2-inch ASTM A36/A36M steel-plate ST50H stud connector designed to support out-of-plane loading of cantilevered partial wall systems that are unsupported at the top track.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide ClarkDietrich; Pony Wall PW24 or approved equal.
   2. Minimum Base-Steel Thickness: 0.0966-in
   3. Size (Height; Width by Length): 23 3/4-inches; with 3 3/8-in by 8-in long plate.

2.03 SUSPENSION SYSTEMS:

A. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.

B. Hanger Attachments to Concrete:

1. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193 or AC308 as appropriate for the substrate.
    a. Uses: Securing hangers to structure.
    b. Type: Torque-controlled, adhesive anchor or adhesive anchor.
    c. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Power-Actuated Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

C. Wire Hangers: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.16 inch (4.12 mm) in diameter.

D. Carrying Channels (Main Runners): Cold-rolled, commercial-steel sheet with a base-steel thickness of 0.0538 inch (1.367 mm) and minimum 1/2-inch- (13-mm-) wide flanges.
1. Depth: 2-1/2 inches (64 mm).

E. Furring Channels (Furring Members):
1. Cold-Rolled Channels: 0.0538-inch (1.367-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges, 3/4 inch (19 mm) deep.
2. Steel Studs and Tracks: ASTM C645.
    a. Minimum Base-Steel Thickness: 0.0179 inch (0.455 mm).
    b. Depth: 3-5/8 inches (92 mm).
3. Embossed, High-Strength Steel Studs and Tracks: ASTM C645.
    a. Minimum Base-Steel Thickness: 0.0147 inch (0.373 mm).
    b. Depth: 3-5/8 inches (92 mm).
4. Hat-Shaped, Rigid Furring Channels: ASTM C645, 7/8 inch (22 mm) deep.
    a. Minimum Base-Steel Thickness: 0.0179 inch (0.455 mm).

F. Grid Suspension System for Gypsum Board Ceilings: ASTM C645, direct-hung system composed of main beams and cross-furring members that interlock.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Armstrong World Industries, Inc.
    b. Rockfon (Rockwool International).
    c. USG Corporation.

2.04 AUXILIARY MATERIALS:

A. General: Provide auxiliary materials that comply with referenced installation standards.
1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:

A. Coordination with Sprayed Fire-Resistive Materials:

1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling tracks to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches (610 mm) o.c.
2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that are required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

3.03 INSTALLATION, GENERAL:

A. Installation Standard: ASTM C754.
   1. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 that apply to framing installation.
B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.
C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
D. Install bracing at terminations in assemblies.
E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.04 INSTALLING FRAMED ASSEMBLIES:

A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
   1. Single-Layer Application: 16 inches (406 mm) o.c. unless otherwise indicated.
   2. Multilayer Application: 16 inches (406 mm) o.c. unless otherwise indicated.
   3. Tile Backing Panels: 16 inches (406 mm) o.c. unless otherwise indicated.
B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
C. Install studs so flanges within framing system point in same direction.
D. Install tracks at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.
   1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
   2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install track section (for cripple studs) at head and secure to jamb studs.
      a. Install two studs at each jamb unless otherwise indicated.
   3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
   4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
      a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
   5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.

E. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.

3.05 INSTALLING CEILING SUSPENSION SYSTEMS:

A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
   1. Hangers: 48 inches (1219 mm) o.c.
   2. Carrying Channels (Main Runners): 48 inches (1219 mm) o.c.
   3. Furring Channels (Furring Members): 16 inches (406 mm) o.c.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:
   1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
      a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
   2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
      a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
   3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
   4. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
   5. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

E. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

F. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet (3 mm in 3.6 m) measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 09 22 16

SECTION 09 29 00 – GYPSUM BOARD

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. Interior gypsum board.
   2. Tile backing panels.

1.03 RELATED REQUIREMENTS:

A. SECTION 09 21 16.23 "GYPSUM BOARD SHAFT WALL ASSEMBLIES" for metal shaft-wall framing, gypsum shaft liners, and other components of shaft-wall assemblies.
B. SECTION 09 22 16 "NON-STRUCTURAL METAL FRAMING" for non-structural steel framing and suspension systems that support gypsum board panels.

1.04 REFERENCED STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
B. American National Standards Institute:
   1. ANSI A108/A118/A136.1 - Installation of Ceramic Tile.
C. ASTM International:
   1. ASTM C 475/C 475M - Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
   2. ASTM C 665 - Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
   3. ASTM C 834 - Specification for Latex Sealants.
   4. ASTM C 840 - Specification for Application and Finishing of Gypsum Board.
   5. ASTM C 919 - Use of Sealants in Acoustical Applications.
   6. ASTM C 954 - 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.
   7. ASTM C 1002 - Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
   8. ASTM C 1047 - Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.
   9. ASTM C 1396/C 1396M - Specification for Gypsum Board.
   10. ASTM C 1629/C 1629M - Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels.
   11. ASTM D 3273 - Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
   12. ASTM D 3274 - Test Method for Evaluating Degree of Surface Disfigurement of Paint Films by Fungal or Algal Growth, or Soil and Dirt Accumulation.
   13. ASTM E 90 - Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
   14. ASTM E 119 - Test Methods for Fire Tests of Building Construction and Materials.

15. ASTM E 413 - Classification for Rating Sound Insulation.

D. California Department of Public Health:
   1. Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers.

1.05 SUBMITTALS:

A. Product Data: For each type of product.
   1. Product Data: For adhesives and sealants, indicating VOC content.
   2. Laboratory Test Reports: For adhesives and sealants, indicating compliance with requirements for low-emitting materials.
   3. Laboratory Test Reports: For ceiling and wall materials, indicating compliance with requirements for low-emitting materials.

1.06 QUALITY ASSURANCE:

A. Obtain each type of gypsum panel and joint finishing material from a single source with resources to provide products of consistent quality in appearance and physical properties.

1.07 DELIVERY, STORAGE AND HANDLING:

A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.08 FIELD CONDITIONS:

A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.
B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
C. Do not install panels that are wet, moisture damaged, and mold damaged.
   1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
   2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.
C. Ceiling and wall materials shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.02 GYPSUM BOARD, GENERAL:

A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.03 INTERIOR GYPSUM BOARD:

A. Gypsum Board, Type X: ASTM C 1396/C 1396M.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Gypsum.
      b. CertainTeed Corporation.
      c. Georgia-Pacific Gypsum LLC.
      d. National Gypsum Company.
      e. USG Corporation.
   2. Thickness: 5/8 inch (15.9 mm).
   3. Long Edges: Tapered and featured (rounded or beveled) for prefilling.

B. Flexible Gypsum Board: ASTM C 1396/C 1396M. Manufactured to bend to fit radii and to be more flexible than standard regular-type gypsum board of same thickness.
   1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
      a. CertainTeed Corporation.
      b. Georgia-Pacific Gypsum LLC.
      c. National Gypsum Company.
      d. USG Corporation.
   2. Thickness: 1/4 inch (6.4 mm).
   3. Long Edges: Tapered.

C. Gypsum Ceiling Board: ASTM C 1396/C 1396M.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Gypsum.
      b. CertainTeed Corporation.
      c. Georgia-Pacific Gypsum LLC.
      d. National Gypsum Company.
      e. USG Corporation.
   2. Thickness: 1/2 inch (12.7 mm).
   3. Long Edges: Tapered.

D. Abuse-Resistant Gypsum Board: ASTM C 1396/C 1396M gypsum board, tested according to ASTM C 1629/C 1629M.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Gypsum.
      b. CertainTeed Corporation.
      c. Georgia-Pacific Gypsum LLC.
      d. National Gypsum Company.
      e. PABCO Gypsum.
      f. USG Corporation.
   2. Core: 5/8 inch (15.9 mm), Type X.
   3. Surface Abrasion: ASTM C 1629/C 1629M, meets or exceeds Level 3 requirements.
   4. Indentation: ASTM C 1629/C 1629M, meets or exceeds Level 1 requirements.
   5. Soft-Body Impact: ASTM C 1629/C 1629M, meets or exceeds Level 2 requirements.

6. Hard-Body Impact: ASTM C 1629/C 1629M, meets or exceeds Level 1 requirements according to test in Annex A1.
7. Long Edges: Tapered.
8. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

E. Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M. With moisture- and mold-resistant core and paper surfaces.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Gypsum.
b. CertainTeed Corporation.
c. Georgia-Pacific Gypsum LLC.
d. National Gypsum Company.
e. PABCO Gypsum.
f. USG Corporation.
2. Core: 5/8 inch (15.9 mm), Type X.
3. Long Edges: Tapered.
4. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

F. Acoustically Enhanced Gypsum Board: ASTM C 1396/C 1396M. Multilayer products constructed of two layers of gypsum boards sandwiching a viscoelastic sound-absorbing polymer core.
1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
a. National Gypsum Company.
b. CertainTeed Corporation
c. PABCO Gypsum
2. Core: 5/8 inch (15.9 mm), Type X
3. Long Edges: Tapered.

2.04 TILE BACKING PANELS:

A. Cementitious Backer Units: ANSI A118.9 and ASTM C 1288 or ASTM C 1325, with manufacturer's standard edges.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. CertainTeed Corporation.
b. National Gypsum Company.
c. USG Corporation.
d. PABCO Gypsum
2. Thickness: 5/8 inch (15.9 mm).
3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

2.05 TRIM ACCESSORIES:

A. Interior Trim: ASTM C 1047.
1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet.
2. Shapes:
a. Cornerbead.

b. LC-Bead: J-shaped; exposed long flange receives joint compound.
c. L-Bead: L-shaped; exposed long flange receives joint compound.
d. Expansion (control) joint.
e. Reveal Bead: Architectural reveal bead; exposed flanges receive joint compound.
f. Z Shadow Bead: Z-shaped; exposed long flange receives joint compound.

B. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Flannery Trim, Inc.
b. Fry Reglet Corporation.
c. Gordon, Inc.
d. Pittcon Industries.
2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221 (ASTM B 221M), Alloy 6063-T5.

2.06 JOINT TREATMENT MATERIALS:
A. General: Comply with ASTM C 475/C 475M.
B. Joint Tape:
1. Interior Gypsum Board: Paper.
2. Tile Backing Panels: As recommended by panel manufacturer.
C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
a. Use setting-type compound for installing paper-faced metal trim accessories.
3. Fill Coat: For second coat, use setting-type, sandable topping compound.
4. Finish Coat: For third coat, use drying-type, all-purpose compound.
5. Skim Coat: For final coat of Level 5 finish, use drying-type, all-purpose compound.
D. Joint Compound for Tile Backing Panels:
1. Cementitious Backer Units: As recommended by backer unit manufacturer.

2.07 AUXILIARY MATERIALS:
A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.
B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
C. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.
1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.
2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
D. Sound-Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

E. Acoustical Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Accumetric LLC.
      b. Everkem Diversified Products, Inc.
      c. Franklin International.
      d. Grabber Construction Products.
      e. Hilti, Inc.
      f. Pecora Corporation.
      g. Specified Technologies, Inc.
      h. USG Corporation.

F. Thermal Insulation: As specified in SECTION 07 21 00 "THERMAL INSULATION."

G. Vapor Retarder: As specified in SECTION 07 26 00 "VAPOR RETARDERS."

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

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

3.02 APPLYING AND FINISHING PANELS, GENERAL:

A. Comply with ASTM C 840.

B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.5 mm) of open space between panels. Do not force into place.

D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

E. Form control and expansion joints with space between edges of adjoining gypsum panels.

F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
   1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. (0.7 sq. m) in area.
   2. Fit gypsum panels around ducts, pipes, and conduits.
   3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- (6.4- to 9.5-mm-) wide joints to install sealant.

G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

I. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

J. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.03 APPLYING INTERIOR GYPSUM BOARD:

A. Install interior gypsum board in the following locations:
   1. Type X: Vertical surfaces unless otherwise indicated.
   2. Ceiling Type: Ceiling surfaces.
   3. Abuse-Resistant Type: At corridors.
   4. Moisture Resistant Interior Type: At restrooms and within 4’-0” of any plumbing fixture.

B. Acoustically Enhanced Type: As indicated on Drawings Single-Layer Application:
   1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
   2. On partitions/walls, apply gypsum panels [vertically (parallel to framing)] [horizontally (perpendicular to framing)] unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
      a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
   3. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

C. Multilayer Application:
   1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches (400 mm) minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
   2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
   3. Fastening Methods: Fasten base layers and face layers separately to supports with screws.

D. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written instructions and temporarily brace or fasten gypsum panels until fastening adhesive has set.

E. Curved Surfaces:

1. Install panels horizontally (perpendicular to supports) and unbroken, to extent possible, across curved surface plus 12-inch- (300-mm-) long straight sections at ends of curves and tangent to them.
2. For double-layer construction, fasten base layer to studs with screws 16 inches (400 mm) o.c. Center gypsum board face layer over joints in base layer, and fasten to studs with screws spaced 12 inches (300 mm) o.c.

3.04 APPLYING TILE BACKING PANELS:

A. Cementitious Backer Units: ANSI A108.11, at locations indicated to receive tile.
B. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.05 INSTALLING TRIM ACCESSORIES:

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
B. Control Joints: Install control joints at locations indicated on Drawings and according to ASTM C 840 and in specific locations approved by Architect for visual effect.
C. Interior Trim: Install in the following locations:
   1. Cornerbead: Use at outside corners.
   2. LC-Bead: Use at exposed panel edges.
   3. L-Bead: Use where indicated.
   4. Reveal Bead: Use where indicated.
   5. Curved-Edge Cornerbead: Use at curved openings.
D. Aluminum Trim: Install in locations indicated on Drawings.

3.06 FINISHING GYPSUM BOARD:

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
B. Prefill open joints, rounded or beveled edges, and damaged surface areas.
C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
   1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
   2. Level 2: Panels that are substrate for tile.
   3. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
      a. Primer and its application to surfaces are specified in SECTION 09 91 23 "INTERIOR PAINTING."
   4. Level 5: At elevator lobby ceilings and break room/corridor soffit.
      a. Primer and its application to surfaces are specified in SECTION 09 91 23 "INTERIOR PAINTING."
E. Interior Moisture Resistant Panels: Finish according to manufacturer's written instructions.
F. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.07 PROTECTION:

A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

C. Remove and replace panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 09 29 00

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SECTION 09 30 00 - TILING

PART 1 - GENERAL

1.01 SUMMARY:

A. SECTION Includes:

1. Modular tiles, membrane underlayments, setting materials, grouting materials, accessories, and supplementary items necessary for installation.

1.02 DEFINITIONS:

A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 and ANSI A137.3 apply to Work of this SECTION unless otherwise specified.

B. Module Size: Actual tile size plus joint width indicated.

C. Face Size: Actual tile size, excluding spacer lugs.

D. Ceramic (Mosaic) Tile: Tile formed by either the dust-pressed or plastic method, usually 1/4 in to 3/8 in (6 mm to 10 mm) thick, and having a facial area of less than 6 sq in (3900 mm²). Ceramic mosaic tile may be of either porcelain or natural clay composition and they may be either plain or with an abrasive mixture throughout.

E. Porcelain Tile: A ceramic tile or paver tile that is generally made by the dust-pressed method of a composition resulting in a tile that is dense, impervious, fine grained, and smooth with sharply formed face and with a porosity of less than 0.5.

F. Wall Tile: A glazed tile with a body that is suitable for interior use and which is usually non-vitreous and is not required nor expected to withstand excessive impact or be subject to freezing and thawing conditions.

1.03 ACTION SUBMITTALS:

A. Product Data: Manufacturers technical literature for each product and system indicated.

B. Include manufacturers specifications for materials, finishes, construction details, installation instructions, and recommendations for maintenance.

C. Shop Drawings:

1. Include plans of rooms and elevations of walls showing tile and patterns; include sections showing underlayments, setting materials, and grouting materials.

2. Include details showing widths and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.

D. Samples for Verification Purposes: Submit samples for each item listed below of size and construction indicated. Where products involve normal color and texture variations, include sample sets showing the full range of variations expected.

1.04 Tile: Each type and composition of tile and for each color and finish required.
INFORMATIONAL SUBMITTALS:

A. List of Materials for Layered Mock-Up for Construction Quality Purposes:

B. Product, material, and equipment names, model numbers, lot numbers, batch numbers, source of supply, and other information required to identify items used.

1. Receipt of list does not constitute acceptance of deviations from Contract Documents, unless such deviations are specifically approved by Architect in writing.

C. Warranty:

1. Provide manufacturers written warranty covering materials and installation (labor) stating obligations, remedies, limitations, and exclusions.

1.05 CLOSEOUT SUBMITTALS:

A. Maintenance Instructions: Include in operation and maintenance manual required by DIVISION 01 SECTION CLOSEOUT REQUIREMENTS. Submit manufacturer's instructions for maintenance of installed work, including methods and frequency for maintaining optimum condition under anticipated use. Include precautions against cleaning materials and methods which may be detrimental to finishes and performance.

1.06 DELIVERY, STORAGE, AND HANDLING:

A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.
B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
D. Store liquid materials in unopened containers and protected from freezing.
E. Handle tile that has temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

1.07 PROJECT CONDITIONS:

A. Environmental Limitations: Install tile only when construction in room is completed and ambient temperature and humidity conditions are being maintained to comply with referenced standards and manufacturer's written instructions.

1.08 COORDINATION:

A. Coordinate installation of products and systems with interfacing and adjoining construction to provide a successful installation without failure.

1.09 WARRANTY:

A. Installer's Warranty: Furnish installer's written workmanship warranty signed by an authorized representative using installer's standard form agreeing to provide labor required to repair or replace work which exhibits workmanship defects. Defects is defined to include but not limited to deterioration or failure to perform as required.
B. Warranty Period: Installer shall warrant the installation to be free from workmanship Defects for a period of 2 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS AND PRODUCTS:

A. Acceptable Manufacturers: Subject to compliance with requirements of Contract Documents as judged by the Architect, provide product by one of manufacturers listed. If not listed, submit as substitution according to the Conditions of the Contract and DIVISION 01 SECTION SUBSTITUTION PROCEDURES.
B. Basis of Design (Product Standard): Contract Documents are based on products and systems specified to establish a standard of quality. Other manufacturers offering products having equivalent characteristics may be considered, provided deviations are minor and comply with requirements of Contract Documents as judged by the Architect.
Selections: As scheduled or as indicated in Design Selections.

2.02 MATERIALS, GENERAL:

A. Single Source Responsibility: Furnish each type of product from single manufacturer. Provide secondary materials only as recommended by manufacturer of primary materials.

B. Tile: For each tile, obtain of same color, finish, composition, and type, from same source and production run.

1. Setting and Grouting Materials: Obtain ingredients of uniform quality for each mortar and grout component from single manufacturer.

2.03 CERAMIC TILE PRODUCTS:

A. Material Quality Standard: ANSI A137.1 Specifications for Ceramic Tiling and ANSI A137.3 Specifications for Gauged Porcelain Tiles and Gauged Porcelain Tile Panels/Slabs for types, compositions, and grades of tiling indicated.

B. Furnish tiling complying with Standard Grade requirements, unless otherwise indicated.

C. Ceramic Tile, General: Thin ceramic surfacing unit made from clay, porcelain, or mixture of ceramic materials, glazed or unglazed, fired above red heat to temperature sufficient to produce specific physical properties and characteristics specified.

D. Factory Blending: For tile exhibiting color variations, blend tile in factory and package so that tile units taken from one package show the same range in colors as those taken from other packages and match approved samples.

E. Mounting: Where factory-mounted tile is used, provide back- or edge-mounted tile assemblies as standard with manufacturer. Where tile is intended for installation in wet exposure areas, do not use factory mounted tile assemblies unless tile manufacturer states that this type of mounting is suitable for installation indicated.

2.04 WATERPROOF MEMBRANE UNDERLAYMENTS FOR INTERIOR APPLICATIONS:

A. Fluid Applied Waterproof Membrane for Wall Tiling in Toilet Rooms:

B. Single component self-curing liquid rubber polymer waterproofing membrane.

C. Laticrete International Inc.; Hydro Ban Waterproofing and Crack Isolation Membrane.

2.05 SETTING MATERIALS - MORTAR AND GROUT:

A. Material Quality Standards: ANSI A118 Series as indicated.

B. LHT Latex-Portland Cement Mortar:

C. Material Quality Standard: ANSI A118.4 and ANSI A118.15, with the following physical properties:

1. Manufacturer's premium polymer modified LHT mortar product; gray color. Use white color with light colored stone, translucent marble or light color grout as recommended by manufacturer.
   a. Integral antimicrobial product added during manufacturing to resist mold and mildew growth.
   b. Non-sag capability.
   c. Suitable for use in LHT mortar beds up to 1/2 in (12 mm) thick.
2. Manufacturers and Products - Gauged Tile Panels / Slabs:
   a. Comply with ANSI A108.19 Interior Installation of Gauged Porcelain Tiles and Gauged Porcelain Tile Panels/Slabs by the Thin-Bed Method bonded with Modified Dry-Set Cement Mortar or Improved Modified Dry-Set Cement Mortar.
   b. Confirm with tile manufacturer and mortar setting material manufacturers the use of required setting materials, methods and cure times.
   c. Thin-Set Latex-Portland Cement Mortar (For All Tile Types Except Glass):

D. Material Quality Standard: ANSI A118.4 and ANSI A118.15, with the following physical properties:
   1. Manufacturer's premium polymer modified thin-set product; gray color. Use white color with light colored stone, translucent marble or light color grout as recommended by manufacturer.
      a. Integral antimicrobial product added during manufacturing to resist mold and mildew growth.
      b. Non-sag capability.
      c. Suitable for use in thin set mortar beds up to 1/4 in (6 mm) thick.
   2. Manufacturers and Products - Wall Tiling:
      a. ARDEX Engineered Cements; X 77 Microtec.
      b. Custom Building Products; ProLite Tile & Stone Mortar.
      c. Laticrete International, Inc.; Laticrete Tri-Lite Large and Heavy Tile Mortar.
      d. Mapei Corp.; Keraflex Super Mortar.

E. Latex-Portland Cement Grout for Tile Joints:
   1. Unsanded Grout:
      a. Material Quality Standard: ANSI A118.7, with following physical properties:
      b. Manufacturer's premium polymer modified unsanded grout product.
         1) Integral antimicrobial product added during manufacturing to resist mold and mildew growth.
   2. Manufacturers and Products:
      a. ARDEX Engineered Cements; FG-C Unsanded Grout.
         1) Custom Building Products; Prism Surecolor Grout.
         2) Laticrete International, Inc.; Permacolor Grout.
         3) Laticrete International, Inc.; Permacolor Select NS.
         4) Mapei Corp.; Ultracolor Plus FA Grout.
      b. Locations: Tile Joints less than 1/8 in (3 mm) wide.
   3. Sanded Grout:
      a. Material Quality Standard: ANSI A118.7, with following physical properties:
      b. Manufacturer's premium polymer modified sanded grout product.
         1) Integral antimicrobial product added during manufacturing to resist mold and mildew growth.
      c. Manufacturers and Products:
         1) ARDEX Engineered Cements; FL Rapid Set, Flexible, Sanded Grout.
         2) Custom Building Products; Prism Surecolor Grout.
         3) Laticrete International, Inc.; Permacolor Grout.
         4) Laticrete International, Inc.; Permacolor Select Grout.
         5) Mapei Corp.; Ultracolor Plus FA Grout.
      d. Locations: Tile Joints 1/8 in (3 mm) wide and larger.

2.06 ELASTOMERIC SEALANTS:

A. Sealant Colors: Match color of adjacent grout unless otherwise indicated.
B. Mildew-Resistant Wall Joint Sealant:
   1. Material Quality Standard: ASTM C 920, Type S, Grade NS, Class 25, with following physical properties:
   2. Integral antimicrobial product added during manufacturing to resist mold and mildew growth.
      a. Intended for sealing interior ceramic tile joints and other nonporous substrates.

b. Resistant to in-service exposures of high humidity and temperature extremes.
c. Use Related to Exposure: T (Traffic).

3. Description: One-part mildew-resistant silicone sealant.
4. Manufacturers and Products:
   a. ARDEX Engineered Cements; SX.
   b. Custom Building Products; Commercial 100% Silicone Caulk.
   c. Laticrete International, Inc.; Latasil.
   d. Mapei Corp.; Mapesil T.

C. Backer Rods:
1. Material Quality Standard: ASTM C 1330, Type B.
2. Description: Non-gassing (when punctured), bi-cellular polyethylene or polyolefin foam rod with a surface skin, of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
3. Manufacturers and Products:
   a. BASF Construction Chemicals; MasterSeal 921 (Formerly Sonneborn Soft Backer Rod).
   b. Nomaco Inc.; Sof Rod.

D. Backer Tape: Bond-breaking polyethylene or other plastic tape, self-adhesive where applicable, recommended by sealant manufacturer for preventing sealant from adhering to back of joint where such adhesion would result in sealant failure.

2.07 RELATED MATERIALS:

A. Cementitious Underlayments: Trowelable or self-leveling as required by conditions; pre-mixed, latex-modified, Portland cement based formulation provided by or specifically approved by setting material manufacturer; include primers if required for concrete substrate condition.

B. Patching Compounds: Trowelable pre-mixed, latex-modified, Portland cement based formulation provided by or specifically approved by setting material manufacturer; include primers if required for concrete substrate condition.

C. Metal Transition Strips (Tile to Adjacent Flooring Material):
1. Schluter Systems LP; Schiene, stainless steel.

D. Glass-Fiber Tape: Self-adhering, alkali-resistant, glass-fiber tape, 10 by 10 or 10 by 20 threads per 1 in (25 mm).; minimum 2 in (50 mm) wide.

E. Tile Cleaner: Neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, provided by or specifically approved by tile and grout manufacturers.

F. Grout Sealer: Manufacturers standard silicone product for sealing grout joints and that does not change color or appearance of grout.

2.08 MIXING MORTARS AND GROUT:

A. General Procedures:
1. Mix to comply with referenced quality standards and manufacturers written instructions.
2. Add materials, water, and additives in accurate proportions.
3. Use type of mixing equipment, speeds, containers, time, and other procedures to produce uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Acceptance of Surfaces and Conditions: Examine substrate surfaces to which tile will be installed for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed only when unsatisfactory conditions have been corrected in a manner complying with the Contract Documents. Starting work within a particular area will be construed as acceptance.

B. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.

1. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.

3.02 INSTALLATION, GENERAL:

A. Installation Quality Standard: In addition to standards listed elsewhere, perform tile work according to following, unless otherwise specified:

B. Respective manufacturers written installation instructions.

1. Accepted submittals.
2. Contract Documents.
3. ANSI A108 installation method indicated.
4. TCNA installation method indicated.

C. General Requirements:

1. Extend tile into recesses and under or behind equipment and fixtures to form a complete covering without interruptions unless otherwise indicated.
2. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
3. Accurately form intersections and returns.
4. Perform cutting and drilling of tile without marring visible surfaces.
5. Grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints, to form smooth edges.
6. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so that plates, collars, or covers overlap tile by not less than 1/8 in (3 mm).

D. Jointing Pattern:

1. Unless otherwise indicated, lay tile in grid pattern.
2. Align joints when adjoining tiles on floor, base, walls, and trim are same size.
3. Lay out tile work and center tile fields in both directions in each space or on each wall area. Adjust to minimize tile cutting.
4. Provide uniform joint widths of size recommended by tile and grout manufacturer unless otherwise indicated.
5. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so that extent of each sheet is not apparent in finished work.

E. Wainscots: Lay out tile to next full tile beyond dimensions indicated, and finish with bullnose shape.

3.03 PREPARATION:

A. General: Comply with manufacturer's instructions, recommendations, and specifications for cleaning and surface preparation. Surfaces shall have no defects, contaminants, or errors which would result in poor or potentially defective installation or would cause latent defects in Work.

B. Substrate Cleaning: Remove curing compounds, coatings, laitance, efflorescence, concrete dust, dirt, oil, gypsum board dust, paint, and other residue that would adversely affect or reduce bonding.

C. Substrate Joints, Gaps, Penetrations, and Different Substrates within Shower and Tub Enclosures: Prior to installing tile, seal the following joints, gaps, and spaces between differing materials as follows:

D. Base of Wall Joints within Shower and Tub Enclosures: Apply wall joint sealant at joint between Coated Glass-Mat Water Resistant Board (specified in DIVISION 09 SECTION GYPSUM BOARD ASSEMBLIES) and Tub Enclosure or Prefabricated Shower Receptor, Thick-set Mortar Bed, or floor slab to create water resistant barrier in accordance with TCNA Installation B420.

1. Penetrations: Apply wall joint sealant at penetrations through wall substrates to create water resistant barrier; especially at piping and valve penetrations.
2. Toilet Accessories: Apply wall joint sealant at fastener penetrations and around perimeter of backing plates to create water resistant barrier.
3. Joints and Corners: Apply glass-fiber tape to joints and corners of substrates within Showers and Tub Enclosures with thin-set mortar.

E. Blending: Verify tile has been factory blended and packaged as specified; if not, either return to manufacturer or blend tiles at site before installing.

F. Field-Applied Temporary Protective Coating: Where needed to prevent grout from staining or adhering to exposed tile surfaces, pre-coat with continuous film of temporary protective coating, taking care not to coat unexposed tile surfaces.

3.04 WATERPROOF MEMBRANE UNDERLAYMENT INSTALLATION:

A. Installation Quality Standard: ANSI A108.13 and manufacturers written instructions to produce waterproof membrane of uniform thickness and bonded securely to substrate.

3.05 TILE INSTALLATION:

A. Comply with TCNAs Handbook for Ceramic Tile Installation for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 Series Specifications for Installation of Ceramic Tile that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.

B. Installation Quality Standard: Install tile according to following standards:

1. LHT Mortar: ANSI A108.5; for floor tiles larger than 8 in by 8 in (200 mm by 200 mm) or with at least one side greater than 15 in (375 mm) and where subfloor is not recessed.
2. Thin-set Latex-Portland Cement Mortar: ANSI A108.5; for floor tiles 8 in by 8 in (200 mm by 200 mm) and smaller where subfloor is not recessed; and for interior wall tiles.
3. Latex-Portland Grout: ANSI A108.10, typical unless indicated otherwise.
4. Interior Gauged Porcelain Tiles and Panels/Slabs: A108.19

C. Grout Joint Widths: Unless indicated otherwise, install the respective types of tile with the following grout joint widths, unless otherwise recommended by tiling and grout manufacturers.

D. Ceramic Mosaic Tile - Less than 6 sq in (3900 mm²): 1/16 in (1.5 mm).

1. Paver Tile - 6 sq in (3900 mm²) or More: 1/4 in (6 mm).

E. Metal Trim: Install at locations indicated and where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with top of tile.

F. Grout Sealer: Apply grout sealer to cementitious grout joints in tile floors according to grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

3.06 MOVEMENT JOINTS:

A. Movement Joints, General: Installation Quality Standard: In accordance with TCNA Movement Joint Design Essentials EJ171 and as specified below.

B. Wall Joints: The following conditions shall not be grouted; install wall joint sealant and backer rod or backer tape:

1. Gypsum board assembly control joints.
2. Building expansion joints, unless scheduled for expansion joint cover.
3. Interior corners of tiled walls, including shower and bathtub walls.
4. Around substrates and tile at penetrations through tiled substrates.
5. At one side of changes in direction or plane of wall.
6. At joint closest and parallel to changes in substrates supporting tile between wall and floor.

3.07 CLEANING:

A. Cleaning:

1. Acids are not permitted, nor will they be allowed.
2. Clean tile surfaces so they are free of foreign matter.
3. Remove grout residue from tile as soon as possible.
4. No sooner than 10 days after installation, clean grout smears and haze from tile according to tile and grout manufacturer's written instructions. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned.
5. Protect metal surfaces and plumbing fixtures from effects of cleaning.
6. Flush surfaces with clean water before and after cleaning.
7. Remove temporary protective coating by method recommended by coating manufacturer that is acceptable to tile and grout manufacturer. Trap and remove coating to prevent it from clogging drains.

3.08 DEMONSTRATION:

A. Cleaning and Maintenance Training: Provide instruction to Owner's personnel for cleaning and maintenance of installed work, including methods and frequency for maintaining optimum condition under anticipated use; include precautions against cleaning materials and methods which may be detrimental to finishes and performance.

3.09 PROTECTION:

A. Coverings: When recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. Before final inspection, remove protective coverings and rinse neutral cleaner from tile surfaces.

B. Traffic Restrictions: Prohibit foot and wheel traffic from tiled floors for at least 7 days after grouting is completed.

3.10 INTERIOR TILE INSTALLATION SCHEDULE:

A. Walls and Floors, Gauged Porcelain Tile Panels and Slabs:
   1. ANSI A 108.19 Interior Installation of Gauged Porcelain Tile and Gauged Porcelain Tile Panels/Slabs (Material and Installation Standards), 2017 or Current Version.

B. Walls, Gypsum Board Substrate:
   1. TCNA Installation Method W243: Thin-set Latex-Portland cement mortar over coated-glass-mat gypsum board; Latex-Portland Cement Grout.

END OF SECTION 09 30 00

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SECTION 09 51 13 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.01 SUMMARY:

A. SECTION Includes: Acoustical lay-in ceiling panels, exposed metal suspension systems, and supplementary items necessary for installation.

1.02 ACTION SUBMITTALS:

A. Product Data: Manufacturer's technical literature for each product and system indicated.
   1. Include manufacturer's specifications for materials, finishes, construction details, installation instructions, and recommendations for maintenance.

B. Product Schedule: Use same designations indicated on the Finish Schedule and Drawings.

C. Samples for Verification Purposes: Full-size units of each type of ceiling assembly indicated; in sets for each color, texture, and pattern specified, showing the full range of variations expected in these characteristics.
   1. Acoustical Panels: Set of 6 in (150 mm) square samples of each type, color, pattern, and texture.
   2. Exposed Suspension-System Members, Moldings, and Trim: Set of 12 in (300 mm) long samples of each type, finish, and color.

1.03 CLOSEOUT SUBMITTALS:

A. Maintenance Data: To include in maintenance manuals.

1.04 DELIVERY, STORAGE, AND HANDLING:

A. Deliver acoustical panels, suspension-system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical panels, permit them to reach room temperature and stabilized moisture content.

C. Handle acoustical panels carefully to avoid chipping edges or damaging units.

1.05 PROJECT CONDITIONS:

A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1.06 COORDINATION:

A. Coordinate installation of products and systems with interfacing and adjoining construction to provide a successful installation without failure.

B. Furnish layouts for cast-in-place anchors, clips, and other ceiling anchors. Furnish cast-in-place anchors and similar devices to other trades for installation well in advance of time needed for coordinating other work.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Acceptable Manufacturers: Subject to compliance with requirements of Contract Documents as judged by the Architect, provide product by one of manufacturers listed. If not listed, submit as substitution according to the Conditions of the Contract and DIVISION 01 SECTION "SUBSTITUTION PROCEDURES".
   1. Armstrong World Industries, Inc.
   2. CertainTeed Corporation.
   3. Chicago Metallic / Rockfon.
   4. Lindner Ceiling Systems.
   5. OWA USA.
   6. USG Interiors, Inc.; Subsidiary of USG Corporation.

B. Basis of Design (Product Standard): Contract Documents are based on products and systems specified to establish a standard of quality. Other manufacturers offering products having equivalent characteristics may be considered, provided deviations are minor and comply with requirements of Contract Documents as judged by the Architect.
   1. Selections: As scheduled or as indicated in Design Selections.

2.02 MATERIALS, GENERAL:

A. Single Source Responsibility: Furnish each type of product from single manufacturer. Provide secondary materials only as recommended by manufacturer of primary materials.
   1. Obtain both acoustical ceiling panels and suspension system from the same manufacturer if both are offered by the manufacturer.

2.03 PERFORMANCE REQUIREMENTS:

A. General Performance: Comply with performance requirements specified, as determined by testing of products and systems representing those indicated for this Project, without failure due to defective manufacture, fabrication, installation, or other defects in construction.

B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: Class A according to ASTM E 1264.
   2. Smoke-Developed Index: 450 or less.

2.04 ACOUSTICAL PANELS, GENERAL:

A. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectance's, unless otherwise indicated.
   1. Selections: As scheduled or as indicated in Design Selections.

2.05 METAL SUSPENSION SYSTEMS, GENERAL:

A. Metal Suspension System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635/C 635M.

B. Finishes and Colors, General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish for type of system indicated.

C. Attachment Devices: Size for five times design load indicated in ASTM C 635/C 635, Table 1, Direct Hung, unless otherwise indicated. Comply with seismic design requirements.
   1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing according to ASTM E 488/E 488M or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
      a. Cast-in-place anchors, designed for attachment to concrete.
      b. Post-installed expansion anchors.
      c. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 for Class SC1 service condition.
   2. Powder-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing according to ASTM E1190, conducted by a qualified testing and inspecting agency.
      a. Manufacturers:
         1) Construction Materials, Inc.
         2) Heckman Building Products, Inc.
         3) Hilti Corp.
         4) ITW Ramset/Red Head.
         5) Powers Fasteners.
         6) Simpson Strong Tie Anchor Systems.
   3. For post-tensioned concrete, anchors shall not exceed 1 in (25 mm) embedment. Obtain Structural Engineer's written approval for all proposed anchors in post-tensioned concrete prior to installation.

D. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
   1. Wire:
      a. Zinc-Coated Carbon-Steel Wire: ASTM A 641 / A 641M, Class 1 zinc coating, soft temper.
   2. Size: Select wire diameter so its stress at 3 times hanger design load (ASTM C 635/C 635M, Table 1, Direct Hung) will be less than yield stress of wire, but provide not less than 0.106 in (2.69 mm) diameter wire.

E. Clean-Room Gasket System: Where indicated, provide manufacturer's standard system, including manufacturer's standard gasket and related adhesives, tapes, seals, and retention clips, designed to seal out foreign material from and maintain positive pressure in clean room.

F. Clean-Room Sealant for Concealed Joints: Manufacturer's standard nondrying, non-hardening, non-skinning, non-staining, gunnable, synthetic-rubber sealant recommended for sealing interior concealed joints.

2.06 METAL EDGE MOLDINGS AND TRIM:

A. Edge Moldings and Trim: Manufacturer's standard moldings for edges and penetrations that fit acoustical panel edge details and suspension systems indicated; formed from sheet metal of same material and finish as that used for exposed flanges of suspension system runners.
   1. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.

2. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
3. For narrow-face suspension systems, provide suspension system and manufacturer's standard edge moldings that match width and configuration of exposed runners.
4. Where required by Code or authorities having jurisdiction, provide 2 in (50 mm) wide wall angle around the ceiling perimeter in Seismic Design Categories D, E, and F.

B. Specialty Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements.
1. Baked-Enamel or Powder-Coat Finish: Minimum dry film thickness of 1.5 mils (0.04 mm). Comply with ASTM C 635/C 635M and coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
2. Basis of Design (Product Standard) Manufacturer and Product: Armstrong World Industries, Inc.; Axiom series, with manufacturer's 30 year warranty.

2.07 METAL SUSPENSION SYSTEM FOR ACOUSTICAL PANEL CEILINGS:

A. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653 / A 653M, not less than G30 (Z90) coating designation, with prefinished 15/16 in (24 mm) wide metal caps on flanges.

B. Structural Classification: Heavy-duty system.
1. End Condition of Cross Runners: Override (stepped) type.
2. Face Design: Flush face.
3. Cap Material: Steel sheet.
4. Cap Finish: Painted white, unless indicated otherwise.
5. Manufacturers and Products:
   a. Armstrong World Industries, Inc.; Prelude XL.
   b. CertainTeed Corporation; Classic Stab.
   c. Chicago Metallic / Rockfon.; 1200 System.
   d. USG Interiors, Inc.; Donn DX.

C. Narrow-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653 / A 653M, not less than G30 (Z90) coating designation, with prefinished 9/16 in (15 mm) wide metal caps on flanges.
1. Structural Classification: Heavy-duty system.
2. End Condition of Cross Runners: Override (stepped) type.
3. Face Design: Flush face.
4. Cap Material: Steel sheet.
5. Cap Finish: Painted white, unless indicated otherwise.
6. Manufacturers and Products:
   a. Armstrong World Industries, Inc.; Suprafine XL.
   b. CertainTeed Corporation; Elite Narrow Stab.
   c. Chicago Metallic / Rockfon.; 4000 Tempra.
   d. USG Interiors, Inc.; Donn Centricitee DXT.

2.08 ACOUSTICAL SEALANT:

A. Acoustical Sealant: As specified in DIVISION 07 SECTION JOINT SEALANTS.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Acceptance of Surfaces and Conditions: Examine substrates to receive products and systems and associated work for compliance with requirements and other conditions affecting performance. Proceed only when unsatisfactory conditions have been corrected in a manner complying with Contract Documents. Starting work within a particular area will be construed as acceptance of surface conditions.

3.02 INSTALLATION, GENERAL:

A. Installation Quality Standards: In addition to standards listed elsewhere, perform Work according to following, unless otherwise specified:
   1. Respective manufacturer's written installation instructions.
   2. Accepted submittals.
   3. Contract Documents.

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

3.03 PREPARATION:

A. General: Comply with manufacturer's instructions, recommendations, and specifications for cleaning and surface preparation. Surfaces shall have no defects, contaminants, or errors which would result in poor or potentially defective installation or would cause latent defects in Work.

B. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

3.04 INSTALLATION OF ACOUSTICAL PANEL CEILINGS:

A. Installation Quality Standard: Install acoustical ceiling panels according the following standards, seismic design requirements and manufacturer's written instructions.
   1. ASTM C 636 / C 636M Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels.

B. Suspend ceiling hangers from building's structural members and as follows:
   1. Install hangers plumb and free from contact with mechanical and electrical equipment, insulation, or other objects within ceiling plenum that are not part of supporting structural frame or ceiling suspension system.
   2. Within limitations allowed by installation quality standards, splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
   3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by installation quality standards.

4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
5. Do not support ceilings directly from permanent metal forms. Fasten hangers to cast-in-place hanger inserts, power-actuated fasteners, or drilled-in anchors that extend through forms into concrete.
6. Do not attach hangers to steel deck tabs.
7. Do not attach hangers to steel roof deck. Attach hangers to structural members.
8. Space hangers not more than 48 in (1200 mm) on center along each member supported directly from hangers, unless otherwise indicated; and provide hangers not more than 8 in (200 mm) from ends of each member.
9. Do not connect or suspend any ceiling components from ducts, pipes or conduit.
10. Do not make local kinks or bends in hanger wires as a means of leveling.

C. Install edge moldings and trim at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
2. Screw attach moldings to substrate at intervals not more than 16 in (400 mm) on center and not more than 3 in (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 in per 12 ft (3 mm per 3.6 m). Miter corners accurately and connect securely.
3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
4. Provide control joints where joints occur in abutting surfaces.
5. Hold tees in place with concealed clips.

D. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
1. Space steel main runners at 48 in (1200 mm) on center.

E. Install acoustical panels with undamaged edges and fitted accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
1. Arrange directionally patterned acoustical panels with pattern running in one direction parallel to long axis of space.
2. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension system runners and moldings.
3. For reveal-edged panels on suspension system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
4. For reveal-edged panels on suspension system members with box-shaped flanges, install panels with reveal surfaces in firm contact with suspension system surfaces and panel faces flush with bottom face of runners.
5. Paint cut panel edges remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
6. Clean Room Installations: Install clean-room gasket system in areas indicated, sealing each panel and fixture as recommended by panel manufacturer's written instructions.

3.05 PROTECTION:

A. Protect products and systems from damage during installation and remainder of construction period according to manufacturer's instructions.

3.06 CLEANING:

A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.

B. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

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SECTION 09 65 00 - RESILIENT FLOORING

PART 1 - GENERAL

1.01 SUMMARY:

A. SECTION Includes: Resilient flooring products and systems and supplementary items necessary for installation.
   1. Resilient sheet flooring.
   2. Luxury vinyl tile flooring.

B. Related Section:
   1. Resilient wall base, reducer strips, and other accessories installed with resilient flooring are specified in DIVISION 09 SECTION "RESILIENT BASE AND ACCESSORIES".

1.02 UNIT PRICES:

A. Concrete Moisture Barrier: Include a unit price to provide Concrete Moisture Barrier Floor Treatment to concrete floor decks.
   a. Unit of measurement: Sufficient material to cover 100 sq ft (9 sq m).
   b. Unit price shall include:
      1) Any required additional substrate preparation for moisture vapor reducing membrane.
      2) Post-installation verification testing of moisture vapor transmission rate.

1.03 ACTION SUBMITTALS:

A. Product Data: Manufacturer's technical literature for each product and system indicated.
   1. Include manufacturer's specifications for materials, finishes, recommended adhesives, construction details, installation instructions, and recommendations for maintenance.

B. Shop Drawings for Special Patterns: Show layout and details of special patterns for resilient flooring.

C. Product Schedule: Use same designations indicated on the Finish Schedule and Drawings.

D. Product Test Reports: Written reports based on evaluation of comprehensive tests performed by qualified testing agency indicating that each product complies with requirements.

E. Samples for Verification Purposes: In manufacturer's standard size, but not less than 6 in by 9 in (150 mm by 230 mm) sample of each different color and pattern of resilient flooring product specified, showing the full range of variations expected in these characteristics. Label each sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in Schedules.

1.04 INFORMATIONAL SUBMITTALS:

A. Manufacturer's Project Acceptance Document: Certification by the manufacturer that its product(s) are approved, acceptable, suitable for use in specific locations, for specific details, and for applications indicated, specified, or required.
   1. Product Compatibility: On installations incorporating products provided by more than one manufacturer, each manufacturer's certificate shall include specific reference to and approval of the other manufacturer's products.

1.05 CLOSEOUT SUBMITTALS:

A. Maintenance Instructions: Include in operation and maintenance manual as required by DIVISION 01 SECTION "CLOSEOUT PROCEDURES". Submit manufacturer's instructions for maintenance of installed work, including methods and frequency for maintaining optimum

condition under anticipated use. Include precautions against cleaning materials and methods which may be detrimental to finishes and performance.

1.06 QUALITY ASSURANCE:

A. Slip Resistance: Provide products identical to those tested for slip resistance per ASTM D 2047 with a static coefficient of friction not less than 0.6 for level surfaces and 0.8 for ramped surfaces.

B. Fire-Test-Response Characteristics: Provide products with the following fire-test-response characteristics as determined by testing identical products per test method indicated below by a testing and inspecting agency acceptable to authorities having jurisdiction.

1. Critical Radiant Flux: Class I, 0.45 W/sq. cm or greater when tested per ASTM E 648.
2. Smoke Density: Maximum specific optical density of 450 or less when tested per ASTM E 662.

1.07 DELIVERY, STORAGE, AND HANDLING:

A. Store flooring products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 85 deg F (29 deg C).

1. Resilient Sheet Flooring: Store sheet flooring rolls upright.
2. Resilient Tile Flooring: Store floor tiles on flat surfaces.

1.08 PROJECT CONDITIONS:

A. Unless otherwise approved in writing by the manufacturer, do not begin flooring installation unless permanent building HVAC system is operational and capable of maintaining relative humidity and temperature of not less than 70 deg F (21 deg C) or more than 85 deg F (29 deg C) for at least 48 hours before installation, during installation, and after installation.

1. Maintain relative humidity of not more than the designed relative humidity for spaces to receive flooring.

B. Maintain flooring products prior to installation at the same temperature as the space where they are to be installed.

C. Close spaces to traffic during flooring installation and for time period after installation recommended by manufacturer.

D. Install flooring products after other finishing operations, including painting, have been completed.

E. Do not install flooring over concrete substrates until slabs have cured and are sufficiently dry to bond with adhesive, as determined by flooring manufacturer's recommended tests. Refer to "Preparation" Article for requirements.

1.09 COORDINATION:

A. Coordinate installation of products and systems with interfacing and adjoining construction to provide a successful installation without failure.

1.10 WARRANTY FOR LUXURY VINYL TILE:

A. Manufacturer's Warranty: Furnish manufacturer's written material and labor warranty signed by an authorized representative using manufacturer's standard form agreeing to furnish materials and labor required to repair or replace work which exhibits material defects caused by manufacture or design and installation of product. "Defects" are defined to include but not limited to deterioration or failure to perform as required.

1. Public Areas Warranty Period: Manufacturer shall warrant the products to be free from material and labor Defects for a period of 10 years from date of Substantial Completion.

B. Installers Warranty: Furnish installer's written workmanship warranty signed by an authorized representative using installers standard form agreeing to provide labor required to repair or replace work which exhibits workmanship defects. "Defects" is defined to include but not limited to deterioration or failure to perform as required.
   1. Warranty Period: Installer shall warrant the installation to be free from workmanship Defects for a period of 2 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Basis of Design (Product Standard): Contract Documents are based on products and systems specified to establish a standard of quality. Other manufacturers offering products having equivalent characteristics may be considered, provided deviations are minor and comply with requirements of Contract Documents as judged by the Architect.
   1. Selections: As scheduled or as indicated in Design Selections.

2.02 MATERIALS, GENERAL:

A. Single Source Responsibility: Furnish each type of product from single manufacturer. Provide secondary materials only as recommended by manufacturer of primary materials.

2.03 RESILIENT SHEET FLOORING MATERIALS:

A. Vinyl Sheet Floor Coverings: ASTM F 1303, Type I or II, Grade 1, Class A (fibrous) or B (nonfoamed plastic) backing or ASTM F 1913 unbacked as required by product selection.

B. Sheet Flooring Thickness: As scheduled.

C. Heat-Welding Seam Bead: Solid-strand product of floor covering manufacturer for heat welding seams.
   1. Selections: As scheduled or as indicated in Design Selections.

D. Integral Cove Base Accessories: Resilient accessories recommended by flooring manufacturer with selections as follows:
   1. Basis of Design: Burke Mercer Flooring Products; Division of Burke Industries, Inc.
      a. Cap Strip: No. 040 round vinyl cap.
      b. Cove Strip: No. 070 flexible vinyl cove stick with nominal 1 in (25 mm) radius.
      c. Reducer: No. 633 vinyl reducer, 1 in (25 mm) wide by 1/8 in (3 mm) high.

2.04 LUXURY VINYL TILE FLOORING MATERIALS:

A. LVT Class: ASTM F1700 Composition of Material: Class III Printed Film Vinyl Plank or Tile, Type B (Embossed).
   1. Size and Squareness: ASTM F 2055, plus or minus 0.016-inch per linear foot in size and less than 0.010-inch for squareness.
   2. Overall Thickness: 0.1875-inch (4 mm and thicker).
      a. Wear Layer Thickness: ASTM F386, plus or minus 0.020-inch (0.5 mm).
   3. Backing Class: Commercial Grade.
   4. Dimensional Stability: ASTM F2199, less than 0.020-inch per linear foot.
   5. Residual Indentation: ASTM 1914, less than 8 percent total thickness.
   6. Flexibility: ASTM F137, less than 1.0-inch diameter, no cracks or breaks.

7. Chemical Resistance: ASTM F 925, no more than slight change in surface dulling, attack or color change.
8. Heat resistance: ASTM F1514, less than 8 color change.
9. Light Resistance: ASTM F1515, less than 8 color change.
10. Static Load Limit: ASTM F 970, 750 psi minimum.

2.05 ACCESSORY MATERIALS:

A. Concrete Slab Primer: Non-staining type as recommended by flooring manufacturer.
B. Trowelable Leveling and Patching Compounds: Latex-modified, Portland-cement-based formulation provided or approved by flooring manufacturer for products and applications indicated.
C. Grounding Strips: Provided or approved by manufacturer; type and size that maintains electrical continuity of floor covering system to ground connection.
D. Adhesives: Water-resistant type recommended by flooring manufacturer suitable for products, applications, and substrate conditions indicated.
   1. Product Compatibility: Provide Manufacturer's written recommendation for each product within an assembly. On installations incorporating products provided by more than one manufacturer, each manufacturer shall approve in writing all adhesives that are in contact with their products.
   2. Provide epoxy adhesives in areas with high rolling loads.
E. Concrete Moisture Barrier Floor Treatment:
   1. Epoxy-Based Moisture Barrier Floor Treatment: Two-component, high-performance, non-flammable, rapid drying, water based, low odor, low VOC, two-component, penetrating epoxy; formulated to reduce moisture vapor transmission and surface alkalinity from concrete substrates, including aged or freshly placed ("green") concrete, prior to installation of impervious glued-down finish flooring specified in other DIVISION 09 SECTIONS.
      a. Basis of Design (Product Standard): Bostik, Inc.; D-250.
   2. Cementitious Overcoat: Fast-setting latex-fortified Portland cement skim coating intended for interior uses.
      a. Basis of Design (Product Standard): Bostik, Inc.; Webcrete 95.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Acceptance of Surfaces and Conditions: Examine substrates to receive products and systems and associated work for compliance with requirements and other conditions affecting performance. Proceed only when unsatisfactory conditions have been corrected in a manner complying with Contract Documents. Starting work within a particular area will be construed as acceptance of surface conditions.

3.02 INSTALLATION, GENERAL:

A. Installation Quality Standards: In addition to standards listed elsewhere, perform Work according to following, unless otherwise specified:
   1. Respective manufacturer's written installation instructions.
   2. Accepted submittals.
   3. Contract Documents.

3.03 PREPARATION:

A. General: Comply with manufacturer's instructions, recommendations, and specifications for cleaning and surface preparation. Surfaces shall have no defects, contaminants, or errors which would result in poor or potentially defective installation or would cause latent defects in Work.

B. Concrete Substrates: Prepare according to ASTM F 710.

1. Verify that concrete substrate finishes comply with requirements specified in DIVISION 03 SECTION "CONCRETE FINISHING" for concrete substrates receiving resilient flooring.
2. Verify that concrete substrates are free of cracks, ridges, depressions, scale, and foreign deposits.
3. Verify that concrete substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Unless concrete has been water-cured, then proceed with the following:
    a. Bead-blast concrete substrate with an apparatus that abrades the surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
    b. Repair damaged and deteriorated concrete according to flooring manufacturer's written recommendations.
4. Determine adhesion and dryness characteristics by performing the following tests as recommended by flooring manufacturer.
5. Alkalinity and Adhesion Testing: Perform tests recommended by flooring manufacturer. A pH range of 5 to 9 is required when substrate is wetted with distilled water and pHydrion paper is applied. Proceed with installation only after concrete substrates pass testing.
6. Moisture Testing: Perform one or both of the following tests as recommended by flooring manufacturer. Perform 3 moisture tests for first 1000 sf (92.9 sm) of concrete substrate scheduled to receive flooring and 1 test for each additional 1000 sf (92.9 sm) or fraction thereof. Proceed with installation only after concrete substrates pass testing.
    a. Perform anhydrous calcium chloride test in accordance with ASTM F 1869. Proceed with installation only after concrete substrates have maximum moisture-vapor-emission rate of 3 lbs of water/1000 sf (1.36 kg of water/92.9 sm) in 24 hours.
    b. Perform relative humidity test using in situ probes in accordance with ASTM F 2170. Proceed with installation only after concrete substrates have a maximum 75 percent relative humidity level measurement.
7. Moisture Barrier Floor Treatment: For concrete substrates not meeting moisture test standards specified above, apply epoxy-based moisture floor treatment and cementitious overcoat to concrete substrate in accordance with manufacturer's written instructions.

C. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, and depressions in substrates.

D. Broom and vacuum clean substrates to be covered immediately before flooring product installation. After cleaning, reexamine substrates for moisture, alkaline salts, carbonation, or dust. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.04 INSTALLATION OF RESILIENT FLOORING, GENERAL:

A. Apply concrete slab primer, if recommended by flooring manufacturer, prior to applying adhesive. Apply according to manufacturer's directions.

B. Scribe, cut, and fit flooring to butt neatly and tightly to vertical surfaces and permanent fixtures, including built-in furniture, cabinets, pipes, outlets, edgings, door frames, thresholds, and nosings.
C. Extend flooring into toe spaces, door reveals, closets, and similar openings. Extend flooring to center of door openings.
D. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on substrate. Use chalk or other nonpermanent, non-staining marking device.
E. Adhere flooring to substrates using a full spread of adhesive applied to substrate to comply with flooring manufacturer's written instructions, including those for trowel notching, adhesive mixing, and adhesive open and working times.
   1. Provide completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
F. Hand-roll flooring in both directions from center out to embed flooring in adhesive and eliminate trapped air according to manufacturer's written instructions. At walls, door casings, and other locations where access by roller is impractical, press flooring firmly in place with flat-bladed instrument.

3.05 INSTALLATION OF RESILIENT SHEET FLOORING:

A. Unroll sheet flooring and allow it to stabilize before cutting and fitting, if recommended in writing by manufacturer.
B. Lay out sheet flooring to comply with the following requirements:
   1. Maintain uniformity of sheet flooring direction.
   2. Arrange for a minimum number of seams and place them in inconspicuous and low-traffic areas, and not less than 6 in (150 mm) away from parallel joints in flooring substrates.
   3. Match edges of sheet flooring for color shading and pattern at seams according to manufacturer's written recommendations.
   4. Avoid cross seams.
C. Integral Cove Base: Form integral cove base by flashing sheet flooring up vertical surfaces. Support flooring at horizontal and vertical junction with cove strip. Butt flooring at top of base against cap strip.
D. Heat-Welded Seams: Rout joints and heat weld with welding bead, permanently fusing sections into seamless flooring. Prepare, weld, and finish seams according to manufacturer's written instructions and ASTM F 1516 to produce surfaces flush with adjoining flooring surfaces.

3.06 INSTALLATION OF LUXURY VINYL FLOORING, GENERAL:

A. Apply concrete slab primer, if recommended by LVT flooring manufacturer, prior to applying adhesive. Apply according to manufacturer's directions.
B. Scribe, cut, and fit flooring and underlayment to allow for thermal movement to gap to vertical surfaces and permanent fixtures, including built-in furniture, cabinets, pipes, outlets, edgings, door frames, thresholds, and nosings.
C. Extend flooring into toe spaces, door reveals, closets, and similar openings. Extend flooring to center of door openings.
D. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on substrate. Use chalk or other nonpermanent, non-staining marking device.

E. Where floating installation is indicated or required, maintain a minimum 5/16 inch expansion around perimeter of the room.
F. Where adhered installation is indicated or required, adhere flooring components to substrates using a full spread of adhesive applied to substrate to comply with flooring manufacturer's written instructions, including those for trowel notching, adhesive mixing, and adhesive open and working times.
   1. Provide completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
G. Hand-roll flooring in both directions from center out to embed flooring in adhesive and eliminate trapped air according to manufacturer's written instructions. At walls, door casings, and other locations where access by roller is impractical, press flooring firmly in place with flat-bladed instruments.

3.07 FIELD QUALITY CONTROL:

A. Testing: Engage a qualified testing agency to test electrical resistance of static-control resilient floor covering systems for compliance with requirements.
   1. Arrange for testing after installation static-control adhesives have fully cured and floor covering systems have stabilized to ambient conditions and after ground connections are completed.
B. Static-control resilient floor coverings will be considered defective if they do not pass tests and inspections.
C. Prepare test and inspection reports.

3.08 CLEANING AND PROTECTING:

A. Perform the following operations immediately after installing flooring products:
   1. Remove adhesive and other surface blemishes from exposed surfaces using cleaner recommended by flooring manufacturer.
   2. Sweep or vacuum floor thoroughly.
   3. Do not wash floor until after time period recommended by flooring manufacturer.
   4. Damp-mop floor to remove marks and soil.
B. Protect flooring against mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods recommended in writing by flooring manufacturer.
   1. Cover products installed on floor surfaces with undyed, untreated building paper until just prior to Substantial Completion.
   2. Do not move heavy and sharp objects directly over floor surfaces. Place plywood or hardboard panels over flooring and under objects while they are being moved. Slide or roll objects over panels without moving panels.

END OF SECTION 09 65 00

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SECTION 09 65 13 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY:

A. SECTION Includes: Resilient wall base, resilient flooring accessories, and supplementary items necessary for installation.

1.02 ACTION SUBMITTALS:

A. Product Data: Manufacturer's technical literature for each product and system indicated.
   1. Include manufacturer's specifications for materials, finishes, construction details, installation instructions, and recommendations for maintenance.

B. Product Schedule: Use same designations indicated on the Finish Schedule and Drawings.

C. Samples for Verification Purposes: In manufacturer's standard size, but not less than 12 in (300 mm) sample of each different color and pattern of resilient product specified, showing the full range of variations expected in these characteristics.

1.03 CLOSEOUT SUBMITTALS:

A. Maintenance Data: To include in maintenance manuals.

1.04 QUALITY ASSURANCE:

A. Fire-Test-Response Characteristics: Provide products with the following fire-test-response characteristics as determined by testing identical products per test method indicated below by a testing and inspecting agency acceptable to authorities having jurisdiction.
   1. Critical Radiant Flux: Class I, 0.45 W/sq. cm or greater when tested per ASTM E 648.
   2. Smoke Density: Maximum specific optical density of 450 or less when tested per ASTM E 662.

1.05 DELIVERY, STORAGE, AND HANDLING:

A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by product manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C).

1.06 PROJECT CONDITIONS:

A. Maintain a temperature of not less than 70 deg F (21 deg C) or more than 85 deg F (29 deg C) in spaces to receive resilient products for at least 48 hours before installation, during installation, and for at least 48 hours after installation, unless otherwise recommended by product manufacturer.

B. Maintain resilient products prior to installation at the same temperature as the space where they are to be installed.

C. Close spaces to traffic during installation and for time period after installation recommended by manufacturer.

D. Install resilient products after other finishing operations, including painting, have been completed.

1.07 COORDINATION:

A. Coordinate installation of products and systems with interfacing and adjoining construction to provide a successful installation without failure.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Basis of Design (Product Standard): Contract Documents are based on products and systems specified to establish a standard of quality. Other manufacturers offering products having equivalent characteristics may be considered, provided deviations are minor and comply with requirements of Contract Documents as judged by the Architect.

1. Selections: As scheduled or as indicated in Design Selections.

2.02 MATERIALS, GENERAL:

A. Single Source Responsibility: Furnish each type of product from single manufacturer. Provide secondary materials only as recommended by manufacturer of primary materials.

2.03 RESILIENT MATERIALS:

A. Rubber Wall Base:

1. Standard: ASTM F 1861, Type TS (rubber, vulcanized thermoset) or TP (rubber, thermoplastic), Group 1 and 2.
2. Thickness: Nominal 1/8 in (3 mm).
3. Lengths: Provide longest length(s) available per manufacturer. Provide coils if available in profile(s) indicated.
4. Outside and Inside Corners:
   Job-formed.

B. Resilient Molding Accessories:

1. Carpeting Accessories: Carpet cove cap, carpet step-off, carpet reducer, carpet edge bar.
2. Resilient Flooring Accessories: Reducer strip and others as required.
3. Material: Rubber or metal, as detailed.
4. Lengths: Provide longest length(s) available per manufacturer. Provide coils if available in profile(s) indicated.
5. Color and finish as selected by Architect from manufacturer's standard colors.

2.04 ACCESSORY MATERIALS:

A. Adhesives: Water-resistant type recommended by product manufacturer suitable for products, applications, and substrate conditions indicated.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Acceptance of Surfaces and Conditions: Examine substrates to receive products and systems and associated work for compliance with requirements and other conditions affecting performance. Proceed only when unsatisfactory conditions have been corrected in a manner complying with Contract Documents. Starting work within a particular area will be construed as acceptance of surface conditions.

3.02 INSTALLATION, GENERAL:

A. Installation Quality Standards: In addition to standards listed elsewhere, perform Work according to following, unless otherwise specified:

1. Respective manufacturer's written installation instructions.

2. Accepted submittals.
3. Contract Documents.

3.03 PREPARATION:

A. General: Comply with manufacturer's instructions, recommendations, and specifications for cleaning and surface preparation. Surfaces shall have no defects, contaminants, or errors which would result in poor or potentially defective installation or would cause latent defects in Work.

3.04 INSTALLATION OF RESILIENT WALL BASE:

A. Apply wall base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

B. Install wall base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.

C. Tightly adhere wall base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

D. Do not stretch wall base during installation.

E. Masonry Wall Surfaces: On masonry surfaces or other similar irregular substrates, fill voids along top edge of wall base with manufacturer's recommended adhesive filler material.

F. Job-Formed Corners: Use straight pieces of maximum lengths possible.

1. Outside Corners: Form without producing discoloration (whitening) at bends. Shave back of base at points where bends occur and remove strips perpendicular to length of base that are only deep enough to produce a snug fit without removing more than half the wall base thickness.
2. Inside Corners: Form by cutting an inverted V-shaped notch in toe of wall base at the point where corner is formed. Shave back of base where necessary to produce a snug fit to substrate.

3.05 INSTALLATION OF RESILIENT FLOORING ACCESSORIES:

A. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor coverings that would otherwise be exposed.

3.06 CLEANING AND PROTECTING:

A. Perform the following operations immediately after installing resilient products:

1. Remove adhesive and other surface blemishes from exposed surfaces using cleaner recommended by manufacturer.
2. Sweep or vacuum horizontal surfaces thoroughly.
3. Do not wash resilient products until after time period recommended by manufacturer.
4. Damp-mop surfaces to remove marks and soil.

B. Protect resilient products against mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by resilient product manufacturer.

END OF SECTION 09 65 13

SECTION 09 68 00 - CARPETING

PART 1 - GENERAL

1.01 SUMMARY:

A. SECTION Includes: Carpeting products and systems and supplementary items necessary for installation.

B. Resilient wall base and resilient molding accessories installed with carpeting are specified in DIVISION 09 SECTION "RESILIENT BASE AND ACCESSORIES".

1.02 UNIT PRICES:

A. Concrete Moisture Barrier: Include a unit price to provide Concrete Moisture Barrier Floor Treatment to concrete floor decks.

a. Unit of measurement: Sufficient material to cover 100 sq ft (9 sq m).

b. Unit price shall include:

1) Any required additional substrate preparation for moisture vapor reducing membrane.

2) Post-installation verification testing of moisture vapor transmission rate.

1.03 ACTION SUBMITTALS:

A. Product Data: Manufacturer's technical literature for each product and system indicated.

1. Include manufacturer's specifications for materials, finishes, construction details, installation instructions, and recommendations for maintenance.

B. Shop Drawings: Provide floor plans, including columns, doorways, enclosing walls or partitions, built-in cabinets, and locations of cutouts, to indicate the following:

1. Carpeting type and color.
2. Seam locations, types, and methods.
3. Type of substrate.
4. Type of installation.
5. Pattern type, location, and direction.
6. Pile direction.
7. Type, color, and location of insets and borders.
8. Type, color, and location of edge, transition, and other accessory strips.
9. Transition details to other flooring materials.

C. Product Schedule: Use same designations indicated on the Finish Schedule and Drawings.

D. Samples for Verification Purposes: In manufacturer's standard size, but not less than 6 in by 9 in (150 mm by 230 mm) sample of each different color, texture, and pattern of carpeting product specified, showing the full range of variations expected in these characteristics. Label each sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in Schedules.

1.04 INFORMATIONAL SUBMITTALS:

A. Warranty:

1. Provide manufacturer's written warranty covering materials and installation (labor) stating obligations, remedies, limitations and exclusions.

1.05 CLOSEOUT SUBMITTALS:

A. Maintenance Instructions: Include in operation and maintenance manual as required by DIVISION 01 SECTION "CLOSEOUT PROCEDURES". Submit manufacturer's instructions for maintenance of installed work, including methods and frequency for maintaining optimum condition under anticipated use. Include precautions against cleaning materials and methods which may be detrimental to finishes and performance.

1.06 QUALITY ASSURANCE:

A. Fire-Test-Response Characteristics: Provide products with the following fire-test-response characteristics as determined by testing identical products per test method indicated below by a testing and inspecting agency acceptable to authorities having jurisdiction.
   1. Critical Radiant Flux: Class I, 0.45 W/sq. cm or greater when tested per ASTM E 648.
   2. Smoke Density: Maximum specific optical density of 450 or less when tested per ASTM E 662.

1.07 DELIVERY, STORAGE, AND HANDLING:

A. General: Comply with CRI 104, Section 5, "Storage and Handling".

1.08 PROJECT CONDITIONS:

A. General: Comply with CRI 104, Section 6.1, "Site Conditions; Temperature and Humidity".

B. Environmental Limitations: Do not install carpeting until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

C. Maintain carpeting products prior to installation at the same temperature as the space where they are to be installed.

D. Close spaces to traffic during carpeting installation and for time period after installation recommended by manufacturer.

E. Install carpeting products after other finishing operations, including painting, have been completed.

F. Do not install carpeting over concrete substrates until slabs have cured and are sufficiently dry to bond with adhesive, as determined by carpeting manufacturer's recommended tests. Refer to "Preparation" Article for requirements.

1.09 COORDINATION:

A. Coordinate installation of products and systems with interfacing and adjoining construction to provide a successful installation without failure.

1.10 WARRANTY:

A. Manufacturer's Warranty for Carpeting: Furnish manufacturer's written material and labor warranty signed by an authorized representative using manufacturer's standard form agreeing to furnish materials and labor required to repair or replace work which exhibits material defects caused by manufacture or design and installation of product. "Defects" is defined to include but not limited to deterioration or failure to perform as required.
   1. Coverage of warranty includes but is not limited to more than 10 percent edge raveling, snags, runs, dimensional stability, loss of tuft bind strength, loss of face fiber, and delamination.
   2. Warranty Period: Manufacturer shall warrant the products to be free from material and labor Defects for a period of 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Basis of Design (Product Standard): Contract Documents are based on products and systems specified to establish a standard of quality. Other manufacturers offering products having equivalent characteristics may be considered, provided deviations are minor and comply with requirements of Contract Documents as judged by the Architect.

2.02 MATERIALS, GENERAL:

A. Single Source Responsibility: Furnish each type of product from single manufacturer. Provide secondary materials only as recommended by manufacturer of primary materials.

B. Emissions: Provide carpet that complies with testing and product requirements of CRI's "Green Label Plus" program.

2.03 TILE CARPETING:

A. Basis of Design (Product Standard):

1. Selections: As scheduled or as indicated in Design Selections.

2.04 ACCESSORY MATERIALS:

A. Concrete Slab Primer: Non-staining type as recommended by carpeting manufacturer.

B. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided by or recommended by carpeting manufacturer.

C. Adhesives: Water-resistant, mildew-resistant, nonstaining type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpeting and is recommended or provided by carpeting manufacturer.

D. Concrete Moisture Barrier Floor Treatment:

1. Epoxy-Based Moisture Barrier Floor Treatment: Two-component, high-performance, non-flammable, rapid drying, water based, low odor, low VOC, two-component, penetrating epoxy; formulated to reduce moisture vapor transmission and surface alkalinity from concrete substrates, including aged or freshly placed ("green") concrete, prior to installation of impervious glued-down finish flooring specified in other DIVISION 09 SECTIONS.

a. Basis of Design (Product Standard): Bostik, Inc.; D-250.

2. Cementitious Overcoat: Fast-setting latex-fortified Portland cement skim coating intended for interior uses.

a. Basis of Design (Product Standard): Bostik, Inc.; Webcrete 95.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Acceptance of Surfaces and Conditions: Examine substrates to receive products and systems and associated work for compliance with requirements and other conditions affecting performance. Proceed only when unsatisfactory conditions have been corrected in a manner complying with Contract Documents. Starting work within a particular area will be construed as acceptance of surface conditions.

3.02 INSTALLATION, GENERAL:

A. Installation Quality Standards: In addition to standards listed elsewhere, perform Work according to following, unless otherwise specified:
   1. Respective manufacturer's written installation instructions.
   2. Accepted submittals.
   3. Contract Documents.

3.03 PREPARATION:

A. General: Comply with manufacturer's instructions, recommendations, and specifications for cleaning and surface preparation. Surfaces shall have no defects, contaminants, or errors which would result in poor or potentially defective installation or would cause latent defects in Work.

B. Comply with CRI 104, Section 6.2, "Site Conditions; Floor Preparation" and carpeting manufacturer's written installation instructions for preparing substrates indicated to receive carpeting installation.

C. Concrete Substrates: Prepare according to ASTM F 710.
   1. Verify that concrete substrate finishes comply with requirements specified in DIVISION 03 SECTION "CONCRETE FINISHING" for concrete substrates receiving carpeting.
   2. Verify that concrete substrates are free of cracks, ridges, depressions, scale, and foreign deposits.
   3. Verify that concrete substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Unless concrete has been water-cured, then proceed with the following:
      a. Bead-blast concrete substrate with an apparatus that abrades the surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
      b. Repair damaged and deteriorated concrete according to flooring manufacturer's written recommendations.
   4. Determine adhesion and dryness characteristics by performing the following tests as recommended by flooring manufacturer.
   5. Alkalinity and Adhesion Testing: Perform tests recommended by flooring manufacturer. A pH range of 5 to 9 is required when substrate is wetted with distilled water and pHydrion paper is applied. Proceed with installation only after concrete substrates pass testing.
   6. Moisture Testing: Perform one or both of the following tests as recommended by flooring manufacturer. Perform 3 moisture tests for first 1000 sf (92.9 sm) of concrete substrate scheduled to receive flooring and 1 test for each additional 1000 sf (92.9 sm) or fraction thereof. Proceed with installation only after concrete substrates pass testing.
      a. Perform anhydrous calcium chloride test in accordance with ASTM F 1869. Proceed with installation only after concrete substrates have maximum moisture-vapor-emission rate of 3 lbs of water/1000 sf (1.36 kg of water/92.9 sm) in 24 hours.
      b. Perform relative humidity test using in situ probes in accordance with ASTM F 2170. Proceed with installation only after concrete substrates have a maximum 75 percent relative humidity level measurement.

7. Moisture Barrier Floor Treatment: For concrete substrates not meeting moisture test standards specified above, apply epoxy-based moisture barrier treatment and cementitious overcoat to concrete substrate in accordance with manufacturer's written instructions.

D. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, and depressions in substrates.

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

3.04 INSTALLATION OF TILE CARPETING:

A. Tile Carpet at Concrete Substrates: Comply with CRI 104, Section 13, "Carpet Modules (Tiles)" and carpet manufacturer's written recommendations for full glue-down installation of every tile with releasable adhesive.

B. Install pattern parallel to walls and borders unless otherwise indicated.

3.05 CLEANING AND PROTECTION:

A. Perform the following operations immediately after installing carpeting:
1. Remove excess adhesive and other surface blemishes from exposed surfaces using cleaner recommended by carpeting manufacturer.
2. Remove yarns that protrude from carpeting surface.
3. Vacuum carpeting using commercial machine with face-beater element.

B. Protect installed carpeting to comply with CRI 104, Section 16, "Protecting Indoor Installations".

C. Protect carpeting against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpeting manufacturer.

END OF SECTION 09 68 00

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SECTION 09 91 24 – INTERIOR PAINTING

PART 1 - GENERAL

1.01 SUMMARY:

A. SECTION Includes: Surface preparation and field painting of exposed interior items and surfaces.

B. Surface preparation, priming, and finish coats specified in this SECTION are in addition to shop priming and surface treatment specified in other Sections.

C. Paint exposed surfaces, except where indicated that the surface or material is not to be painted or is to remain natural. If an item or a surface is not specifically mentioned, paint the item or surface the same as similar adjacent materials or surfaces. If a color of finish is not indicated, Architect will select from standard colors and finishes available.

D. Painting includes field painting of exposed bare and covered pipes and ducts, hangers, exposed steel and iron supports, and surfaces of mechanical and electrical equipment that do not have a factory-applied final finish.

E. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels, unless indicated otherwise.

F. Prefinished items include the following factory-finished components:
   1. Prefinished wood doors.
      a. Acoustical materials.
      b. Prefinished Architectural woodwork and cabinets.
      c. Elevator equipment.
      d. Finished mechanical and electrical equipment.
      e. Light fixtures.
      f. Distribution cabinets.
      g. Baked enamel coated items.
      h. Fluoropolymer coated items.
      i. Integral colored plaster.
      j. Integral colored PVC.

G. Concealed surfaces include walls or ceilings in the following generally inaccessible spaces:
   1. Foundation spaces.
      a. Furred areas.
      b. Ceiling plenums.
      c. Utility tunnels.
      d. Pipe spaces.
      e. Duct shafts.
      f. Elevator shafts.

H. Finished metal surfaces include the following:
   1. Anodized aluminum.
      a. Stainless steel.
      b. Chromium plate.
      c. Copper and copper alloys.
      d. Bronze and brass.

I. Operating parts include moving parts of operating equipment and the following:
   1. Valve and damper operators.
      a. Linkages.
      b. Sensing devices.
      c. Motor and fan shafts.

J. Labels: Do not paint over UL, FMG, or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.
1. Embossed UL labels may be used and painted where acceptable to authority having jurisdiction

1.02 DEFINITIONS:
A. MPI Gloss Levels: MPI Gloss and Sheen Standard values are measured per ASTM D523, Method D and are as follows:
1. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees.
2. Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees.
3. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees.
4. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees.
5. Gloss Level 5: 35 to 70 units at 60 degrees.
6. Gloss Level 6: 70 to 85 units at 60 degrees.
7. Gloss Level 7: More than 85 units at 60 degrees.
B. Interior Painting: Generally includes surfaces located in conditioned spaces.

1.03 ACTION SUBMITTALS:
A. Product Data: Manufacturer's technical literature for each product and system indicated.
B. Include manufacturer's specifications for materials, finishes, installation instructions, and recommendations for maintenance.
C. Product List: For each product indicated, include the following:
D. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
1. Printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
E. Samples for Verification: For each type of paint system and each color and gloss of topcoat indicated.
F. Submit Samples on rigid backing, 8 in (200 mm) square.
1. Step coats on Samples to show each coat required for system.
2. Label each coat of each Sample.
3. Label each Sample for location and application area.

1.04 INFORMATIONAL SUBMITTALS:
A. Manufacturers Project Acceptance Document: Certification that products are approved, acceptable, suitable for use in specific locations, for specific details, and for applications indicated, specified, or required, and that warranty will be issued.
B. Certifications by manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).

1.05 QUALITY ASSURANCE:
A. MPI Standards:
B. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
1. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" and "MPI Maintenance Repainting Manual" for products and paint systems indicated.

C. Mockups: Apply benchmark samples of each paint system indicated and each color and finish selected to verify preliminary selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Install mockup in the location and of the size indicated or, if not indicated, as directed by Architect.
   2. Architect will select one surface to represent surfaces and conditions for application of each paint system.

D. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
   1. Other Items: Architect will designate items or areas required.
   2. Demonstrate repair procedures for damaged surfaces.

E. Apply samples, according to requirements for the completed Work, after permanent lighting and other environmental services have been activated. Provide required sheen, color, and texture on each surface.
   1. Final approval of color selections will be based on benchmark samples.
   2. If preliminary color selections are not approved, apply additional benchmark samples of additional colors selected by Architect at no added cost to Owner.
   3. Notify Architect seven days in advance of the dates and times when mock-up will be installed.
   4. Obtain Architect's acceptance of mock-ups before starting fabrication or installation.
   5. Acceptance of mock-ups does not constitute acceptance of deviations from the Contract Documents contained in mock-ups unless such deviations are specifically noted by Contractor and accepted by Architect in writing.
   6. Demolish and remove mock-ups when directed by Architect unless accepted to become part of the completed Work.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).

B. Maintain containers in clean condition, free of foreign materials and residue.
   1. Remove rags and waste from storage areas daily.

1.07 PROJECT CONDITIONS

A. Apply paints only when temperatures of surfaces to be painted and surrounding air are between minimum and maximum range recommended by manufacturer.

B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

1.08 COORDINATION

A. Coordinate installation of products and systems with interfacing and adjoining construction to provide a successful installation without failure.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers and Products:
   1. Sherwin-Williams Company (The).

B. Color and Gloss: As scheduled or as indicated in Design Selections.

2.02 PAINT, GENERAL

A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."

B. Source Limitations: Obtain block fillers and field applied primers for each coating system from the same manufacturer as the finish coats.

C. Material Compatibility:

D. 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.

1. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Acceptance of Surfaces and Conditions: Examine substrates to receive products and systems and associated work for compliance with requirements and other conditions affecting performance. Proceed only when unsatisfactory conditions have been corrected in a manner complying with Contract Documents. Starting work within a particular area will be construed as acceptance of surface conditions.

B. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to shop applicators to ensure use of compatible primers.

3.02 INSTALLATION

A. Installation Quality Standards: In addition to standards listed elsewhere, perform work according to the following, unless otherwise specified in this SECTION:

B. Respective manufacturer's written installation instructions.

1. Approved submittals.
2. Contract Documents.
3. MPI Architectural Painting Specification Manual" or "MPI Maintenance Repainting Manual", as applicable.

3.03 PREPARATION

A. General: Comply with manufacturer's instructions, recommendations and specifications for cleaning and surface preparation. Surfaces shall have no defects or errors which would result in poor or potentially defective installation or would cause latent defects in Work.

B. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" and "MPI Maintenance Repainting Manual" applicable to substrates and paint systems indicated.

C. Remove plates, machined surfaces, and similar items already in place that are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

D. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

1. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates, unless expressly permitted by authorities having jurisdiction for labels intended to be painted.

E. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.

F. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.

G. Steel Substrates: Remove rust and loose mill scale. Clean using methods recommended in writing by paint manufacturer.

H. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by paint manufacturer, and touch up with same primer as the shop coat.

I. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

J. Galvanized metal substrates shall not be chromate passivated. If galvanized metal is chromate passivated, provide surface preparation and primers recommended by manufacturer.

K. Gypsum Board Substrates: Do not begin paint application until finishing compound is dry and sanded smooth.

L. Cotton or Canvas Insulation Covering Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

3.04 APPLICATION

A. Apply paints according to manufacturer's written instructions.

B. Use applicators and techniques suited for paint and substrate indicated.

1. Paint surfaces behind movable items, equipment, and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items, equipment, or furniture with prime coat only.
2. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
3. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces.
4. The number of coats and film thickness required are the same regardless of application method.
5. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
6. Omit primer over metal surfaces that have been shop primed and touchup painted.
7. Allow sufficient time between successive coats to permit proper drying.

C. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat. Tint per manufacturer's technical data for each type of primer or undercoat.

D. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

E. 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.

F. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate to achieve total dry film thickness of the entire system as recommended by manufacturer.

3.05 MECHANICAL AND ELECTRICAL WORK PAINTING AND IDENTIFICATION

A. Painting of Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work to be done when exposed in the following locations:
   1. Occupied Spaces.

B. Equipment includes, but is not limited to, the following:
   1. Uninsulated piping.
   2. Pipe hangers and supports.
   3. Tanks that do not have factory-applied final finishes.
   4. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
   5. Equipment that is indicated to have a factory-primed finish for field painting.

C. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces. Paint with a flat, nonspecular black paint.

D. Pipe Identification: Conform to requirements of ANSI/ASME A13.1 "Scheme for the Identification of Piping Systems".

3.06 FIRE AND SMOKE BARRIER IDENTIFICATION

A. Fire and smoke resistant rated walls shall be effectively and permanently identified with signs, labels or stencils in a manner acceptable to authority having jurisdiction.

B. Identification shall be above decorative ceiling and in concealed spaces, on each segment of the wall and 6'-0" O.C. maximum on each side of wall.

3.07 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. Provide "Wet Paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others to protect their work after completing painting operations.

E. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces to match approved samples.

3.08 INTERIOR PAINTING SCHEDULE

A. Steel Substrates:

B. High-Performance Architectural Latex System: MPI INT 5.1R.

C. Prime Coat: Quick-drying alkyd metal primer (shop primed), MPI #76.
   1. Intermediate Coat: High-performance architectural latex matching topcoat.
   2. Topcoat: Latex, interior, high performance architectural (MPI Gloss Level 2), MPI #138.
   3. Topcoat: Latex, interior, high performance architectural (MPI Gloss Level 3), MPI #139.
   4. Topcoat: Latex, interior, high performance architectural (MPI Gloss Level 4), MPI #140.

5. Topcoat: Latex, interior, high performance architectural, semi-gloss (MPI Gloss Level 5), MPI #141.
6. Gloss and Sheen: As scheduled or as indicated in Design Selections.

D. Galvanized-Metal Substrates:
E. Institutional Low-Odor/VOC Latex System: MPI INT 5.3N.
F. Prime Coat: Waterborne galvanized-metal primer, MPI #134.
1. Intermediate Coat: Institutional low-odor/VOC interior latex matching topcoat.
2. Topcoat: Latex, interior, institutional low odor/VOC, flat (MPI Gloss Level 1), MPI #143.
3. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 2), MPI #144.
4. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 3), MPI #145.
5. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 4), MPI #146.
6. Topcoat: Latex, interior, institutional low odor/VOC, semi-gloss (MPI Gloss Level 5), MPI #147.
7. Topcoat: Latex, interior, institutional low odor/VOC, gloss (MPI Gloss Level 6), MPI #148.
8. Gloss and Sheen: As scheduled or as indicated in Design Selections.

G. Gypsum Board and Plaster (Gypsum and Portland Cement) Substrates:
H. Institutional Low-Odor/VOC Latex System: MPI INT 9.2M.
I. Prime Coat: Institutional low-odor/VOC primer/sealer, MPI 149.
1. Intermediate Coat: Institutional low-odor/VOC interior latex matching topcoat.
2. Topcoat: Latex, interior, institutional low odor/VOC, flat (MPI Gloss Level 1), MPI #143.
3. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 2), MPI #144.
4. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 3), MPI #145.
5. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 4), MPI #146.
6. Topcoat: Latex, interior, institutional low odor/VOC, semi-gloss (MPI Gloss Level 5), MPI #147.
7. Topcoat: Latex, interior, institutional low odor/VOC, gloss (MPI Gloss Level 6), MPI #148.
8. Gloss and Sheen: As scheduled or as indicated in Design Selections.

J. Water-Based Epoxy Coating System: MPI INT 9.2F.
K. Prime Coat: Interior latex primer/sealer, MPI #50.
1. Intermediate Coat: Epoxy-Modified Latex, Interior, matching topcoat.
2. Topcoat: Epoxy-Modified Latex, Interior, semi-gloss (MPI Gloss Level 5), MPI #215.
3. Topcoat: Epoxy-Modified Latex, Interior, gloss (MPI Gloss Level 6), MPI #115.
4. Gloss and Sheen: As scheduled or as indicated in Design Selections.

L. Cotton or Canvas Insulation-Covering Substrates: Including pipe and duct coverings.
M. Institutional Low-Odor/VOC Latex System: MPI INT 10.1D.
N. Prime Coat: Institutional low-odor/VOC primer/sealer, MPI #50.
1. Intermediate Coat: Institutional low-odor/VOC interior latex matching topcoat.
2. Topcoat: Latex, interior, institutional low odor/VOC, flat (MPI Gloss Level 1), MPI #143.
3. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 2), MPI #144.
4. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 3), MPI #145.
5. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 4), MPI #146.
6. Topcoat: Latex, interior, institutional low odor/VOC, semi-gloss (MPI Gloss Level 5), MPI #147.

7. Topcoat: Latex, interior, institutional low odor/VOC, gloss (MPI Gloss Level 6), MPI #148.
8. Gloss and Sheen: As scheduled or as indicated in Design Selections.

END OF SECTION 09 91 24

SECTION 10 21 15 - CUBICLE SPECIALTIES

PART 1 - GENERAL

1.01 SUMMARY:

A. Work required for this SECTION includes cubicle specialties and supplementary items necessary to complete their installation.

1.02 SUBMITTALS:

A. Product Data: Submit manufacturer's specifications to evidence compliance with these specifications.

B. Shop Drawings:

1. Show details of the system, related construction and reflected layout of ceiling areas showing location of tracks in relation to other ceiling mounted items.

C. Indicate materials, finishes, dimensions, thicknesses and/or gages of parts, reinforcement, where applicable, and anchorage including items of hardware and accessories necessary for complete installation.

D. Samples for Verification: Full-size units of each type of the following products:

1. Curtain Fabric: 12 in (300 mm) square swatch or larger Sample as required to show complete pattern repeat, from dye lot used for the Work, with specified treatments applied. Mark top and face of material.

E. Cubicle Schedule: Use same room designations as indicated on Drawings.

1.03 CLOSEOUT SUBMITTALS:

A. Maintenance Data: For each product if specified to include in maintenance manuals specified in DIVISION 01.

1.04 PROJECT CONDITIONS:

A. Environmental Limitations: Do not install cubicle specialties until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Field Measurements: Where products and systems are indicated to fit walls and other construction, verify dimensions by field measurements before fabrication.

PART 2 - PRODUCTS

2.01 MANUFACTURERS AND PRODUCTS:

A. Acceptable Manufacturer and Product: (No Substitutions)

1. On The Right Track.

2.02 PERFORMANCE REQUIREMENTS:

A. Curtains: 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.
   a. Identify fabrics with appropriate markings of applicable testing and inspecting agency.

2.03 CURTAIN TRACKS:

A. Extruded-Aluminum Track: Not less than 1-1/2 inches wide by 3/8 inch high.
   1. Curved Track: Factory fabricated 12-inch-radius bends.
   Finish: Powder coated white finish.

B. Track Accessories(PVC Free): Fabricate splices, connectors, hangers, anchors and mounting plates as required.

C. Loading Zone: Provide (1) loading zone per track layout ot be used as an area for on-loading and off-loading cubicle curtains.

2.04 CURTAIN LOADING TOOL:

A. Provide manufacturer's standard loading tool, The Grabber. Provide at minimum one (1) Grabber Bar per floor.

B. Provide ceiling blocking for acoustical ceiling tiles in width the track will be fastened to the building frame without requiring the use of screws or other mechanical fasteners.

2.05 CURTAINS:

A. Cubicle Curtain Fabric: Subject to compliance with requirements, provide the following:
   1. Refer to Interior Design Selections.

B. Mesh Top: No. 50 (1/2 inch) nylon mesh. Top 19 in (500 mm) of curtain.
   1. Color: As selected by Architect from manufacturer's full range.

C. Fabrication: Fabricate curtains to comply with the following requirements:
   1. Width: Finished width of panel to be 3 in (75 mm) less than specified fabric width.
   2. Length: Equal to floor-to-ceiling height minus depth of track and carrier at top, and minus 15 inch distance above finished floor at bottom.
   3. Mesh Top: Hem 1-1/2 in (38 mm) wide, triple thickness, including turned edges and a row of stitches at the top and bottom of hem, complete with label. Curtains to be fabricated with nylon mesh tops designed for attachment to track without separate hooks.
   4. Bottom Hem: Not less than 1 inch and not more than 1-1/2 in (38 mm) wide, double thickness and double lock stitched.
   5. Side Hems: Not less than 1 in (25 mm) and not more than 1-1/2 in (38 mm) wide, with double thickness and double lock stitch.
   6. Vertical Seams: Not less than 1/2 in (12 mm) wide, double turned and double stitched.
   7. Top Hem: Triple thickness with edges turned and stitched top and bottom.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of work.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:

A. General: Install tracks level and plumb, according to manufacturer's written instructions.

B. Surface Track Mounting: Mechanically attach tracks using manufacturer's recommended anchors and attachment devices.

END OF SECTION 10 21 15

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SECTION 10 26 13 - WALL AND CORNER GUARDS

PART 1 - GENERAL

1.01 SUMMARY:

A. Scope: Impact-resistant wall protection systems, wall and corner guards, and supplementary items necessary for installation.

1.02 ACTION SUBMITTALS:

A. Product Data: Manufacturer's technical literature for each product and system indicated.
   1. Include manufacturer's specifications for materials, finishes, physical characteristics such as durability, resistance to fading, and flame resistance, construction details, installation instructions, and recommendations for maintenance

B. Shop Drawings: Show details of fabrication and installation, including plans, elevations, sections, details of components and attachments to other work. Distinguish between shop and field-assembled work

C. Plastic Samples for Verification Purposes: Submit color samples showing full range of color and texture variations expected in each wall protection system component.

1.03 CLOSEOUT SUBMITTALS:

A. Maintenance Data: Include for each wall protection system component to include in maintenance manuals specified in DIVISION 01. Include recommended methods and frequency for maintaining optimum condition of plastic covers under anticipated traffic and use conditions, and precautions against using cleaning materials and methods that may be detrimental to plastic finishes and performance.

1.04 QUALITY ASSURANCE:

A. Installer Qualifications:
   1. Experience: Installer's personnel with not less than 5 years of experience in the successful performance of Work similar to scope of this Project.
   2. Supervision: Installer shall maintain a competent supervisor at Project while the Work is in progress, and who has not less than 5 years of experience installing products and systems similar to scope of this Project.

B. Fire-Test-Response Characteristics: Provide wall protection system components with surface-burning characteristics indicated, as determined by testing identical materials according to ASTM E 84 by a testing and inspecting agency acceptable to authorities having jurisdiction. Identify wall protection system components with appropriate markings of applicable testing and inspecting agency.

C. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines.

1.05 PROJECT CONDITIONS:

A. Environmental Limitations: Do not deliver or install impact-resistant wall protection units until building is enclosed and weatherproof, wet work is complete and dry, and HVAC system is operating and maintaining temperature at 70 deg F (21 deg C) for not less than 72 hours before beginning installation and for the remainder of the construction period.

1.06 COORDINATION:

A. Coordinate installation of products and systems with interfacing and adjoining construction to provide a successful installation without failure.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Basis of Design (Product Standard): Contract Documents are based on products and systems specified to establish a standard of quality. Other manufacturers/fabricators offering products having equivalent characteristics may be considered, provided deviations are minor and comply with requirements of Contract Documents as judged by the Architect.

2.02 MATERIALS, GENERAL:

A. Single Source Responsibility: Furnish each type of product from single manufacturer. Provide secondary materials only as recommended by manufacturer of primary materials.

2.03 MATERIALS:

A. Engineered PETG (Polyethylene Terepthalate Glycol) Material: Textured, chemical- and stain-resistant, high-impact-resistant co-polymer plastic with integral color throughout; PVC-free with no PBTs or BPA, extruded and sheet material, thickness as indicated.
   1. Impact Resistance: Minimum 25.4 ft-lbf/in. (1356 J/m) of notch when tested according to ASTM D 256, Test Method A.
   2. Chemical and Stain Resistance: Tested according to ASTM D 543 or ASTM D 1308.
   3. Self-extinguishing when tested according to ASTM D 635.
   4. Flame-Spread Index: 25 or less.
   5. Smoke-Developed Index: 450 or less.
   6. Color and Texture: As scheduled or as indicated in Design Selections.
   7. Custom printed units shall be extruded from chemical and stain-resistant PETG with a matte finish. rigid sheet shall be reverse printed by Inpro with customer supplied digital graphics. printed sheet shall have a protective backing.

B. Polycarbonate Plastic Sheet: ASTM D 6098, S-PC01, Class 1 or 2, abrasion resistant; with a minimum impact-resistance rating of 15 ft-lbf/in. (800 J/m) of notch when tested according to ASTM D 256, Test Method A.

C. Aluminum Extrusions: Alloy and temper recommended by manufacturer for type of use and finish indicated, but with not less than strength and durability properties specified in ASTM B 221 (ASTM B 221M) for Alloy 6063-T5.

D. Fasteners: Aluminum, nonmagnetic stainless-steel, or other noncorrosive metal screws, bolts, and other fasteners compatible with items being fastened. Use security-type fasteners where exposed to view.

E. Adhesive: As recommended by impact-resistant plastic wall protection manufacturer.

2.04 WALL AND CORNER GUARDS:

A. Basis of Design (Product Standard): Contract Documents are based on products and systems specified to establish a standard of quality. Other manufacturers/fabricators offering products having equivalent characteristics may be considered, provided deviations are minor and comply with requirements of Contract Documents as judged by the Architect.

1. Manufacturers and Products: As scheduled or as indicated in Design Selections.

2.05 FABRICATION:

A. General Requirements: Fabricate wall protection system components to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including thicknesses of components.
   1. Preassemble components in shop to greatest extent possible to minimize field assembly.

B. Fabricate components with tight seams and joints with exposed edges rolled. Provide surfaces free of wrinkles, chips, dents, uneven coloration, and other imperfections. Fabricate members and fittings to produce flush, smooth, and rigid hairline joints.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Acceptance of Surfaces and Conditions: Examine substrates to receive products and systems and associated work for compliance with requirements and other conditions affecting performance. Proceed only when unsatisfactory conditions have been corrected in a manner complying with Contract Documents. Starting work within a particular area will be construed as acceptance of surface conditions.

3.02 INSTALLATION, GENERAL:

A. Installation Quality Standards: In addition to standards listed elsewhere, perform Work according to following, unless otherwise specified:
   1. Respective manufacturer/fabricator's written installation instructions.
   2. Accepted submittals.
   3. Contract Documents.

3.03 PREPARATION:

A. General: Comply with manufacturer's instructions, recommendations, and specifications for cleaning and surface preparation. Surfaces shall have no defects, contaminants, or errors which would result in poor or potentially defective installation or would cause latent defects in Work.

3.04 EXAMINATION:

A. Acceptance of Conditions: Examine substrate surfaces to which wall protection system components will be installed for compliance with requirements, installation tolerances and other conditions affecting performance. Proceed only when unsatisfactory conditions have been corrected in a manner complying with Contract Documents. Starting work within a particular area will be construed as acceptance.

3.05 INSTALLATION:

A. General: Install impact-resistant wall protection units level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.
   1. Install impact-resistant wall protection units in locations and at mounting heights indicated on Drawings.

2. Provide splices, mounting hardware, anchors, and other accessories required for a complete installation.
   a. Provide anchoring devices to withstand imposed loads.
   b. Where splices occur in horizontal runs of more than 20 ft (6.1 m), splice aluminum retainers and plastic covers at different locations along the run, but no closer than 12 in (300 mm).
   c. Adjust end and top caps as required to ensure tight seams.

B. Impact-Resistant Wall Covering: Install top and edge moldings, corners, and divider bars as required for a complete installation.

3.06 CLEANING:

A. Immediately after completion of installation, clean plastic covers and accessories using a standard, ammonia-based, household cleaning agent.

B. Remove excess adhesive using methods and materials recommended in writing by manufacturer.

END OF SECTION 10 26 13

SECTION 10 28 13 - TOILET ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY:

A. SECTION Includes: Toilet accessories and supplementary items necessary for installation.

1.02 ACTION SUBMITTALS

A. Product Data: Manufacturer's technical literature for each product indicated.

B. Include manufacturer's specifications for materials, finishes, construction details, installation instructions, dimensions, and profiles of individual components.

1. Include details for cutouts required in other Work; include templates, substrate preparation instructions, and directions for preparing cutouts and installing anchoring devices.

1.03 INFORMATIONAL SUBMITTALS

A. Warranty:

B. Provide manufacturer's written warranty covering materials and installation (labor) stating obligations, remedies, limitations and exclusions.

1.04 CLOSEOUT SUBMITTALS

A. Maintenance Data: For inclusion in operation and maintenance manual as required by DIVISION 01 SECTION "OPERATION AND MAINTENANCE DATA". Include manufacturer's instructions for maintenance of installed Work, including methods and frequency for maintaining optimum condition under anticipated use. Include precautions against cleaning products and methods which may be detrimental to finishes and performance.

1.05 PRE-INSTALLATION CONFERENCE

A. Pre-Installation Conference: Before Work begins, conduct conference at Project site.

B. Participants:

1. Architect.
2. Contractor, including superintendent.
3. Installer, including project manager and supervisor.
4. If requested, Manufacturer's qualified technical representative.
5. Installers of other construction interfaced with Work.

C. Minimum Agenda: Installer shall demonstrate understanding of the Work required by describing detailed procedures for preparing, installing, and cleaning the Work. Demonstration shall include, but not be limited to, following topics:

D. Tour representative areas of Work, inspect and discuss condition of substrate, and other preparatory work performed by other trades.

1. Review Contract Document requirements.
2. Review approved submittals.
3. Review inspection and testing requirements.
4. Review environmental conditions and procedures for coping with unfavorable conditions.
5. Resolve deviations or differences between Contract Documents and the manufacturer's specifications.

E. Record discussions, including decisions and agreements, and prepare report.

1.06 COORDINATION

A. Coordinate installation of products with interfacing and adjoining construction to provide a successful installation without failure.

1.07 WARRANTY

A. Mirror Manufacturer's Warranty: Furnish warranty for a period of 15 years from date of Substantial Completion agreeing to replace mirrors that develop visible silver spoilage defects, signed by an authorized representative using manufacturer's standard form.

PART 2 - PRODUCTS

2.01 MANUFACTURERS AND PRODUCTS

A. Acceptable Manufacturers and Products: Subject to compliance with requirements of Contract Documents as judged by the Architect, provide product by one of manufacturers listed. If not listed, submit as substitution according to Conditions of the Contract and DIVISION 01 SECTION "SUBSTITUTION PROCEDURES".

B. A & J Washroom Accessories, Inc.
   1. American Specialties, Inc.
   2. Bobrick Washroom Equipment, Inc.
   3. Bradley Corp.
   4. Brey Krause Manufacturing.
   5. GAMCO, a Division of Bobrick.

C. Shower Curtain Products Only:

D. Barjan Manufacturing Ltd.
   1. Brite Inc.
   2. Gary Manufacturing.

E. Child and Adult Care Products Only:
   1. Brocar Products, Inc. (Foundations Quality Children's Products)
   2. Koala Kare Products.

F. Basis of Design: Contract Documents are based on products specified to establish a standard of quality. Other manufacturers with products having equivalent characteristics may be considered, provided deviations are minor and do not change intended aesthetic, functional and performance requirements as judged by Architect.

2.02 MATERIALS, GENERAL

A. Single Source Responsibility: Furnish each type of product from single manufacturer. Provide secondary materials only as recommended by manufacturer of primary materials.

B. General Requirements:

C. Unless otherwise indicated, fabricate units of all-welded construction, with corners and returns as indicated, tight seams and joints, and exposed edges rolled.
   1. Fabricate frames drawn and leveled, one-piece seamless construction.
   2. Hang doors and access panels with full-length, stainless-steel hinges.
   3. Equip units for concealed anchorage and with corrosion-resistant backing plates.

D. Manufacturer Names or Labels: Not permitted on exposed faces of accessories. Provide printed label or stamped metal nameplate indicating manufacturer's name and product model number on an easily noticeable interior surface or on back surface of each accessory.

E. Keys: Provide minimum of 6 universal keys for internal access to accessories for servicing and resupplying.
F. Accessibility Requirements: Products and installation shall comply with Americans with Disabilities Act (ADA), ANSI A 117.1, and state and local accessibility standards.

2.03 MATERIALS
A. Stainless Steel: ASTM A 666, Type 304, with No. 4 satin finish; minimum 0.0312 in (0.8 mm) (22 gage) nominal thickness unless otherwise indicated.
B. Mirror Glass: ASTM C 1036, Type I, Class 1, Quality q2, nominal 1/4 in (6 mm) thick, with silvering, electroplated copper coating, and protective organic coating.
C. Chrome Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).
D. ABS Plastic: Moldable acrylonitrile-butadiene-styrene resin formulation.
E. HDPE Plastic: Moldable high-density polyethylene resin formulation.
F. Galvanized Steel Mounting Devices: ASTM A 153, hot-dip galvanized after fabrication.
G. Fasteners: Screws, bolts, and other devices of same material as accessory unit, tamper and theft resistant when exposed, and of non-corrosive metal when concealed.
H. Sealant: Silicone mildew resistant sealant specified in DIVISION 07 SECTION "INTERIOR JOINT SEALANTS".

2.04 TOILET ACCESSORIES
A. Refer to accessories schedule on drawings.

PART 3 - EXECUTION

3.01 EXAMINATION
A. Acceptance of Surfaces and Conditions: Examine substrates to receive products and associated work for compliance with requirements and other conditions affecting performance. Proceed only when unsatisfactory conditions have been corrected in a manner complying with Contract Documents. Starting work within a particular area will be construed as acceptance of surface conditions.

3.02 INSTALLATION, GENERAL
A. Installation Quality Standards: In addition to standards listed elsewhere, install toilet accessories according to the following, unless otherwise specified in this SECTION:
B. Respective manufacturer's written installation instructions.
1. Accepted submittals.
2. Contract Documents.

3.03 PREPARATION
A. General: Comply with manufacturer's instructions, recommendations and specifications for cleaning and surface preparation. Surfaces shall have no defects, contaminants, or errors which would result in poor or potentially defective installation or would cause latent defects in Work.

3.04 INSTALLATION

A. General Requirements: Install toilet accessories level, plumb, and firmly anchored in locations and at heights indicated. Use fasteners that are appropriate to substrate indicated and as recommended by respective product manufacturer.

B. Grab Bars: Install to withstand downward load of minimum 250 lbf (1.10 kN) according to ASTM F 446.

C. Accessories within Shower and Tub Alcoves: Set flanges of accessories in sealant, install sealant in screw holes prior setting screws, and cover screw head prior to snapping on cover, to prevent water infiltration.

D. Mirrors: Secure to walls in concealed, tamper-resistant manner with special hangers, toggle bolts, or screws.

END OF SECTION 10 28 13

SECTION 10 44 13 – FIRE PROTECTION CABINETS

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-protection cabinets for the following:
      a. Portable fire extinguisher.
      b. Portable fire extinguisher and fire-hose valve.

1.03 REFERENCED STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. ASTM International:
   1. ASTM A 666 - Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
   2. ASTM C 1048 - Specification for Heat-Strengthened and Fully Tempered Flat Glass.

C. National Association of Architectural Metal Manufacturers:
   1. AMP 500 - Metal Finishes Manual for Architectural and Metal Products.

1.04 PREINSTALLATION CONFERENCE:

A. Preinstallation Conference: Conduct conference at Project site.
   1. Review methods and procedures related to fire-protection cabinets, including, but not limited to, the following:
      a. Schedules and coordination requirements.

1.05 SUBMITTALS:

A. Product Data: For each type of product.
   1. Show door hardware, cabinet type, trim style, and panel style. Include roughing-in dimensions and details showing recessed-, semirecessed-, or surface-mounting method and relationships of box and trim to surrounding construction.

B. Shop Drawings: For fire-protection cabinets.
   1. Include plans, elevations, sections, details, and attachments to other work.

C. Product Schedule: For fire-protection cabinets. Indicate whether recessed, semirecessed, or surface mounted. Coordinate final fire-protection cabinet schedule with fire-extinguisher schedule to ensure proper fit and function.

D. Maintenance Data: For fire-protection cabinets to include in maintenance manuals.

1.06 COORDINATION:

A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers, hose valves indicated are accommodated.

B. Coordinate sizes and locations of fire-protection cabinets with wall depths.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Source Limitations: Obtain fire-protection cabinets, accessories, and fire extinguishers from single source from single manufacturer.

2.02 FIRE-PROTECTION CABINET:

A. Cabinet Type: Suitable for fire extinguisher and extinguisher and hose valve.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Basis of design; Larsens Manufacturing Company; Occult Series:
      a. Babcock-Davis.
      b. Guardian Fire Equipment, Inc.
      c. JL Industries, Inc.; a division of the Activar Construction Products GroupNystrom, Inc.
      d. Potter Roemer LLC.

B. Cabinet Construction: Nonrated, One-hour fire ratedor Two-hour fire rated. As indicated on the drawings.
   1. Fire-Rated Cabinets: Construct fire-rated cabinets with double walls fabricated from 0.043-inch- (1.09-mm-) thick cold-rolled steel sheet lined with minimum 5/8-inch- (16-mm-) thick fire-barrier material. Provide factory-drilled mounting holes.

C. Cabinet Material: Stainless-steel sheet.

D. Recessed Cabinet:
   1. Trimless with Concealed Flange: Surface of surrounding wall finishes flush with exterior finished surface of cabinet frame and door, without overlapping trim attached to cabinet. Provide recessed flange, of same material as box, attached to box, to act as drywall bead.
   2. Trimless with Hidden Flange: Flange of same metal and finish as box overlaps surrounding wall finish and is concealed from view by an overlapping door.
   3. Exposed Flat Trim: One-piece combination trim and perimeter door frame overlapping surrounding wall surface, with exposed trim face and wall return at outer edge (backbend).

E. Cabinet Trim Material: Same material and finish as door.

F. Door Material: Stainless-steel sheet.

G. Door Style: Flush opaque panel, frameless, with no exposed hinges.

H. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
   1. Provideprojecting door pull and self adjusting roller latch .
   2. Provide concealed hinge, permitting door to open 180 degrees.

I. Accessories:
   1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
   2. Door Lock: Cam lock that allows door to be opened during emergency by pulling sharply on door handle.
   3. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated.
      a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER."
         (1) Location: Applied to cabinet door.
         (2) Application Process: Decals.

(3) Lettering Color: Black.
(4) Orientation: Vertical .

J. Materials:
1. Stainless Steel: ASTM A 666, Type 304.
a. Finish: No. 4 directional satin finish,.

2.03 FABRICATION:

A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
1. Weld joints and grind smooth.
2. Miter corners and grind smooth.
3. Provide factory-drilled mounting holes.
4. Prepare doors and frames to receive locks.
5. Install door locks at factory.

B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles.
1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch (13 mm) thick.
2. Miter and weld perimeter door frames and grind smooth.

C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.04 GENERAL FINISH REQUIREMENTS:

A. Comply with NAAMM's AMP 500, "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces of fire-protection cabinets from damage by applying a strippable, temporary protective covering before shipping.

C. Finish fire-protection cabinets after assembly.

D. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine roughing-in for hose valves and cabinets to verify actual locations of piping connections before cabinet installation.

B. Examine walls and partitions for suitable framing depth and blocking where recessed cabinets will be installed.

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

3.02 PREPARATION:

A. Prepare recesses for recessed fire-protection cabinets as required by type and size of cabinet and trim style.

3.03 INSTALLATION:

A. General: Install fire-protection cabinets in locations and at mounting heights indicated.

B. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.

1. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.

C. Identification:
   1. Apply decals at locations indicated.

3.04 ADJUSTING AND CLEANING:

A. Remove temporary protective coverings and strippable films, if any, as fire-protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.

B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.

D. Touch up marred finishes, or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet and mounting bracket manufacturers.

E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 10 44 13

SECTION 10 44 16 – FIRE EXTINGUISHERS

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, mounting brackets for fire extinguishers.

B. Owner-Furnished Material: Hand-carried fire extinguishers.

1.03 RELATED REQUIREMENTS:

A. SECTION 10 44 13 "FIRE PROTECTION CABINETS."

1.04 REFERENCED STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. National Fire Protection Association:

1. NFPA 10 - Portable Fire Extinguishers.

1.05 PREINSTALLATION MEETINGS:

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to fire extinguishers including, but not limited to, the following:

a. Schedules and coordination requirements.

1.06 SUBMITTALS:

A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for mounting brackets.

B. Product Schedule: For mounting brackets. Coordinate final fire-extinguisher schedule with fire-protection cabinet schedule to ensure proper fit and function.

C. Warranty: Sample of special warranty.

1.07 COORDINATION:

A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.08 WARRANTY:

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure of hydrostatic test according to NFPA 10 when testing interval required by NFPA 10 is within the warranty period.

b. Faulty operation of valves or release levers.

2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

2.02 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS:

A. Fire Extinguishers: Owner provided 2-A:10-B:C, 5-lb extinguishers to be located in cabinets on brackets. Cordinate with Owner.

2.03 MOUNTING BRACKETS:

A. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or black baked-enamel finish.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Basis of design; Larsens Manufacturing Company:
   a. Babcock-Davis.
   b. Guardian Fire Equipment, Inc.
   c. JL Industries, Inc.; a division of the Activar Construction Products Group.
   d. Potter Roemer LLC.
2. Source Limitations: Obtain mounting brackets and fire extinguishers from single source from single manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine fire extinguishers for proper charging and tagging.

1. Remove and replace damaged, defective, or undercharged fire extinguishers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:

A. General: Install mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.

1. Mounting Brackets: Refer to Drawing for mounting height above finished floor.

B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION 10 44 16

SECTION 13 49 00 - RADIATION 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 this SECTION.

1.02 SUMMARY:

A. SECTION Includes:
   1. Lead-lined gypsum board.
   2. Lead glass.
   3. Lead-lined hollow-metal frames.
   4. Lead-lined flush wood doors.
   5. Informational signs.

B. Related Requirements:
   1. Gyp, hm frames/doors, lead glass

1.03 DEFINITIONS:

A. Lead Equivalence: The thickness of lead that provides the same attenuation (reduction of radiation passing through) as the material in question under the specified conditions.
   1. Lead equivalence specified for materials used in diagnostic x-ray rooms is as measured at 100 kV unless otherwise indicated.

1.04 PREINSTALLATION MEETINGS:

A. Preinstallation Conference: Conduct conference at project site.
   1. Review methods and procedures related to radiation protection, including, but not limited to, the following:
      a. Sequence and schedule of radiation protection work in relation to other work.
      b. Supplementary lead shielding at duct, pipe, and conduit penetrations of radiation protection.
      c. Methods of attaching other construction and equipment to lead-lined finishes.
      d. Notification procedures for work that requires modifying radiation protection.
      e. Requirements for field quality control.
      f. Refer to Physicists Report requirements. See drawings.

1.05 ACTION SUBMITTALS:

A. Product Data: For each type of product.
   1. Doors and Frames: Include construction details, material descriptions, core descriptions, fire resistance ratings, and finishes.

B. Shop Drawings: Show layout of radiation-protected areas, indicating lead thickness or lead equivalence of components. Show components and installation conditions not fully dimensioned or detailed in product data.
   1. Show ducts, pipes, conduit, and other objects that penetrate radiation protection; include details of penetrations.
   2. Show details of joints between radiation protection materials.
   3. Include door details, including elevations, frame dimensions and profile, and clearances and undercuts.

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

1.06 QUALITY ASSURANCE:

A. Installer Qualifications: Fabricator of products.

1.07 DELIVERY, STORAGE, AND HANDLING:

A. Lead-Lined gypsum panels. Store inside under cover, and keep dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

B. Lead-Lined, Hollow-Metal Doors and Frames: Comply with requirements in SECTION 08 11 13 "HOLLOW METAL DOORS AND FRAMES" for delivery, storage, and handling.

C. Lead-Lined Wood Doors: Comply with requirements in SECTION 08 14 16 "FLUSH WOOD DOORS" for delivery, storage, and handling.

1.08 FIELD CONDITIONS:

A. Environmental Limitations: Do not deliver or install radiation protection until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.09 WARRANTY:

A. Warranty for Lead-Lined Wood Doors: Comply with requirements in SECTION 08 14 16 "FLUSH WOOD DOORS."

PART 2 - PRODUCTS

2.01 SOURCE LIMITATIONS:

A. Obtain each type of radiation protection product from single source from single manufacturer**.**

2.02 PERFORMANCE REQUIREMENTS:

A. Provide materials and workmanship, including joints and fasteners, that maintain continuity of radiation protection at all points and in all directions equivalent to materials specified in thicknesses and locations indicated.

B. Materials, thicknesses, and configurations of radiation protection products indicated are based on radiation protection design prepared by Owner's radiation health physicist. This design is available in drawings.

C. Lead-Lined Assemblies: Unless otherwise indicated, provide lead thickness in lead-lined assemblies of not less than lead thickness indicated for assemblies in which they are installed.

D. Lead Glazing: Unless otherwise indicated, provide lead equivalence of not less than that indicated for assembly in which glazing is installed.

E. Fire-Rated and Smoke-Control Door and Frame Assemblies: Comply with SECTION 08 11 13 "HOLLOW METAL DOORS AND FRAMES" and SECTION 08 14 16 "FLUSH WOOD DOORS"

2.03 LEAD-LINED GYPSUM BOARD:

A. 5/8-inch- thick gypsum board complying with SECTION 09 29 00 "GYPSUM BOARD," of width and length required for support spacing and to prevent cracking during handling, and with a single sheet of lead laminated to the back of the board.
   1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
   2. Lead Sheet Lining: Full width of board and height as indicated on Drawings.
   3. Furnish 2-inch wide lead strips for backing joints.
   4. Furnish finishing materials, accessories, and trim for lead-lined gypsum board complying with SECTION 09 29 00 "GYPSUM BOARD."

2.04 LEAD GLASS:

A. Lead-barium, polished glass containing not less than 60 percent heavy metal oxides, including not less than 48 percent lead oxide by weight.
   1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
   2. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.
   3. Tempered Safety Glass: ASTM C1048, Kind FT (fully tempered), lead glass with thickness as needed.

2.05 LEAD-LINED HOLLOW-METAL FRAMES:

A. Hollow-Metal Frames: Steel frames complying with NAAMM-HMMA 861, except as indicated.
   1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
   2. Provide knocked down frames where indicated.
   3. Provide borrowed lite observation window frames of split or telescoping design with welded corners, allowing frame to be installed after construction of partition.
      a. Construct so lead lining overlaps glazing material perimeter by at least 3/8 inch and furnish removable stops.
   4. Furnish with additional reinforcements and internal supports to adequately carry the weight of lead-lined doors. Install reinforcements and supports before installing lead lining.
   5. Line frame with lead sheet of thickness not less than that required for doors and walls where frames are used. Form lead sheet to match frame contour, continuous in each jamb and across the head, lapping the stops. Form lead shields around areas prepared to receive hardware. Fabricate lead lining wide enough to maintain an effective lap with lead of adjacent shielding.
   6. Finish: Apply manufacturer's factory-applied paint.
      a. Color and Gloss: As selected by Architect from manufacturer's full range.

2.06 LEAD-LINED FLUSH WOOD DOORS:

A. Solid-core wood doors with lead sheet laminated to each side of core, with faces applied over lead lining.
   1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
   2. Construction: Hot pressed, bonded (vertical and horizontal edging is bonded to core), with entire unit abrasive planed before applying lead lining and faces.
   3. Core: Structural composite lumber.

4. Lead Lining: Continuous sheets of lead extending from top to bottom and edge to edge; with total lead thickness not less than that required for partition in which door is installed.
5. Plastic-Laminate Faces: High-pressure decorative laminate complying with NEMA LD 3, Grade HGS; applied to crossbands over core.
6. ANSI/WDMA I.S.1-A Performance Grade: Extra Heavy Duty.

B. Prepare doors to receive glazed lights factory cut and trim openings through doors. Provide removable wood stops for glazed lights.

C. Metal Frames for Glazed Lights: Lead-lined frame formed of 0.048-inch thick, cold-rolled steel sheet; factory primed for paint finish ; and approved for use in doors of fire-protection rating indicated.

D. Shield cutouts for locksets with lead sheet of same thickness used in door. Lap lining of cutouts with door lining.

E. Furnish lead-lined astragals for pairs of doors.

F. Factory fit doors to suit frame openings indicated with 1/16-inch clearance at heads and jambs and minimum clearance at bottom. Factory machine doors for hardware not surface applied.

2.07 INFORMATIONAL SIGNS:

A. Panel Signs: Comply with SECTION 10 14 23 "PANEL SIGNAGE."
1. Color: As selected by Architect from manufacturer's full range of colors.
2. Provide copy indicated or as directed.
3. Indicate lead equivalence in millimeters and heights of radiation protection in inches.

B. High-Pressure-Laminate Signs: High-pressure laminate engraving stock with contrasting face and core, machine engraved from master templates for accurately formed letters, numbers, and symbols.
1. Color: As selected by Architect from manufacturer's full range of colors.
2. Provide copy indicated or as directed.
3. Indicate lead equivalence in millimeters and heights of radiation protection in inches.

C. Rooms Where the Level of Protection Is Uniform Throughout: Provide one sign for each room indicating lead equivalence of partitions, ceilings, floors, doors, and other portions of radiation protection enclosure. Indicate height of radiation protection above floor or indicate that partitions are radiation protected to full height.

D. Rooms Where the Level of Protection Is Not Uniform Throughout: Provide one sign for each room with different lead equivalences in different locations. Indicate, in tabular form, lead equivalence of each wall, partition, ceiling, floor, door, and window. Indicate height of radiation protection above floor or indicate that partitions are radiation protected to full height. Indicate where lead equivalence changes or is not continuous.

E. Rooms Where Some Partitions Are without Radiation Protection: Provide one sign for each partition that contains radiation protection and indicate its lead equivalence. Indicate height of radiation protection above floor or indicate that partitions are radiation protected to full height.

F. Rooms Where Only the Door Has Radiation Protection: Provide one sign for each door indicating its lead equivalence.

G. Mounting: Provide manufacturer's standard two-faced tape or adhesive.

2.08 DOOR AND DOOR FRAME FABRICATION:

A. Hardware Preparation: Factory prepare doors and frames to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping in accordance with

door hardware schedule and templates furnished, as specified in SECTION 08 71 00 "DOOR HARDWARE."

2.09 MISCELLANEOUS MATERIALS:

A. Glazing Compounds, Gaskets, and Accessories: Comply with requirements in SECTION 08 80 00 "GLAZING."

B. Accessories and Fasteners: Manufacturer's standard fasteners and accessories as required for installation, maintaining same lead equivalence as rest of system.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine substrates with Installer present for compliance with requirements, installation tolerances, and other conditions affecting performance of radiation protection.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF LEAD-LINED GYPSUM BOARD:

A. Install and finish lead-lined gypsum board in accordance with SECTION 09 29 00 "GYPSUM BOARD."

B. Install lead-lined gypsum board panels with long edge parallel to supports and lead lining facing supports. Provide blocking at end joints. Install using construction adhesive and supplementary fasteners.

C. NCRP Report No. 147 does not require additional shielding for nails or screws. Revise first paragraph below if additional shielding is required by Project or by authorities having jurisdiction.

D. Install lead-lined gypsum board panels in sequence, so lead lining that extends beyond edge of gypsum board is covered by next panel installed.

E. At joints where lead lining does not extend beyond edge of gypsum board panels, install lead strips 2 inches wide and same thickness as lead lining to face of framing and blocking. Secure lead strips with construction adhesive.

F. Provide shims at face of supports and blocking, where lead lining does not overlap, to provide a uniform plane across panel surfaces.

G. Fasten lead-lined gypsum board to framing, with steel drill screws spaced as recommended in writing by lead-lined gypsum board manufacturer.

H. Two-Layer System: Apply a facing sheet of gypsum board vertically over base sheet, using laminating adhesive recommended in writing by gypsum board manufacturer. Offset joints in finish layer from joints in base layer and fasten at top and bottom of sheet to support finish panel until adhesive has set.

I. Openings: Extend lead-lined gypsum board into frames of openings, lapping lead lining with lead frames or frame linings at least 1 inch. Arrange board around openings, so neither horizontal nor vertical joints occur at corners of openings.

3.03 INSTALLATION OF LEAD-LINED DOORS AND DOOR FRAMES:

A. Install lead-lined steel door frames in accordance with SECTION 08 11 13 "HOLLOW METAL DOORS AND FRAMES."

B. Install lead-lined wood doors in accordance with SECTION 08 14 16 "FLUSH WOOD DOORS."

C. Lead-Lined Hollow-Metal Door Frames: Comply with ANSI/NAAMM-HMMA 840 unless otherwise indicated. Except for frames located in existing walls or partitions, place frames before constructing walls. Set frames accurately in position, plumb, and brace securely until permanent anchors are set.
   1. Provide three anchors per jamb, located adjacent to hinge-on-hinge jamb and at corresponding heights on strike jamb.
   2. In masonry construction, use wire or T-strap anchors, and apply a coat of asphalt mastic or paint to lead lining where lead comes in contact with masonry or grout.
   3. In metal stud construction, use wall anchors attached to studs with screws.
   4. In wood stud construction, use strap anchors attached to studs with screws.

D. Lead-Lined Split-Frame Observation Windows: Install lead-lined hollow-metal frames with split or telescoping design, with leaded side of frame on radiation side of wall.

E. Lead Lining of Frames: Line inside of frames with lead of thickness of not less than that required in doors and walls where frames are used. Form lead to match frame contour, continuous in each jamb and across the head, lapping the stops. Form lead shields around areas prepared to receive hardware. Lap lining over lining in walls at least 1 inch .

F. Install leaded side of frame on radiation side of wall. Lap lead lining of frames over lining in walls at least 1 inch.

G. Lead Glazing: Comply with installation requirements in SECTION 08 80 00 "GLAZING" and with manufacturer's written instructions.

H. Line astragals with lead sheet.

I. Hardware: Line covers, escutcheons, and plates to provide effective shielding at cutouts and penetrations of frames and doors. See SECTION 08 71 00 "DOOR HARDWARE" for other installation requirements.

3.04 INSTALLATION OF PENETRATING ITEMS:

A. At penetrations of lead linings, provide lead shields to maintain continuity of protection.

B. Provide lead linings, sleeves, shields, and other protection in thickness of not less than that required in assembly being penetrated.

C. Secure shields at penetrations using adhesive or wire ties but not penetrating fasteners unless indicated on Drawings.

D. Outlet Boxes and Conduit: Cover or line with lead sheet lapped over adjacent lead lining at least 1 inch . Wrap conduit with lead sheet for a distance of not less than 10 inches from box.

E. Duct Openings: Unless otherwise indicated, line or wrap ducts with lead sheet for distance from partition/ceiling equal to 3 times the largest opening dimension. Lap lead sheet with adjacent lead lining at least 1 inch.

F. Piping: Unless otherwise indicated, wrap piping with lead sheet for a distance of not less than 10 inches from point of penetration.

3.05 FIELD QUALITY CONTROL:

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections after radiology equipment has been installed and placed in operating condition.

B. Correct deficiencies in or remove and replace radiation protection that inspection reports indicate does not comply with specified requirements.

3.06 PROTECTION:

A. Lock radiation-protected rooms once doors and locks are installed, and limit access to only those persons performing work in the rooms.

END OF SECTION 13 49 00

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SECTION 21 13 13 – WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this SECTION.

1.2 SUMMARY:

A. This SECTION includes the following fire-suppression piping inside the building:
   1. Automatic wet-type, Class I standpipe systems.
   2. Wet-pipe sprinkler systems.
   3. Pre-action sprinkler systems, single interlock systems.

B. Refer to the following Specification Sections:
   1. DIVISION 10 SECTION "FIRE PROTECTION CABINETS" and "Fire Extinguishers" for cabinets and fire extinguishers.
   2. SECTION 21 13 16 - DRY PIPE SPRINKLER SYSTEMS
   3. SECTION 28 31 11 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

1.3 DEFINITIONS:

A. High-Pressure Piping System: Fire-suppression piping system designed to operate at working pressure higher than standard 175 psig (1200 kPa).

B. Listed: Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services. In accordance with NFPA all equipment, materials or services shall be listed by an approval agency including the following – UL, FM or other acceptable agencies. This project is insured by FM Global and it is desirable to utilize equipment that is listed in the Factory Mutual approval guide. UL standards are included as a basis-of-design.

1.4 SYSTEM DESCRIPTIONS:

A. Combined Standpipe and Sprinkler System: Fire-suppression system with both standpipe and sprinkler systems. Sprinkler system is supplied from standpipe system.

B. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Single-Interlock Preaction Sprinkler System: Automatic sprinklers are attached to piping containing air. Actuation of fire-detection system in same area as sprinklers opens deluge valve, permitting water to flow into piping and to discharge from sprinklers that have opened. Two smoke detectors are required for actuating valve. Fire alarm contractor to provide all fire alarm devices. Refer to SECTION 21 13 16 DRY PIPE SPRINKLER SYSTEMS for components.

1.5 PERFORMANCE REQUIREMENTS:

A. Standard Piping System Component Working Pressure: Listed for at least 175 psig (1200 kPa). Maintain system pressure below listed pressures with the use of pressure reducing valves on the lower floors as necessary.

B. Fire-suppression sprinkler system design shall be approved by authorities having jurisdiction.
   1. Sprinkler Occupancy Hazard Classifications:
      a. Building Service Areas: Ordinary Hazard, Group 1.

b. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
c. General Storage Areas: Ordinary Hazard, Group 2.
d. Hospitals: Light Hazard.
e. Laboratories: Ordinary Hazard, Group 1.
f. Laundries: Ordinary Hazard, Group 1.
g. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
h. Office and Public Areas: Light Hazard.
i. Patient Care and Staff Areas: Light Hazard.
j. Restaurant Service Areas: Ordinary Hazard, Group 1.

2. Minimum Density for Automatic-Sprinkler Piping Design:
   a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. (6.3 mL/s over 139-sq. m) area.
   b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. (9.5 mL/s over 139-sq. m) area.
   c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. (12.6 mL/s over 139-sq. m) area.
   d. Special Occupancy Hazard: As determined by authorities having jurisdiction.
3. Maximum Protection Area per Sprinkler:
   a. Office Spaces: 225 sq. ft. (20.9 sq. m).
   b. Storage Areas: 130 sq. ft. (12.1 sq. m).
   c. Mechanical Equipment Rooms: 130 sq. ft. (12.1 sq. m).
   d. Electrical Equipment Rooms: 130 sq. ft. (12.1 sq. m).
   e. Other Areas: According to NFPA 13 recommendations, unless otherwise indicated.
4. Total Combined Hose-Stream Demand Requirement: According to NFPA 13, unless otherwise indicated:
   a. Light-Hazard Occupancies: 100 gpm (6.3 L/s) for 30 minutes.
   b. Ordinary-Hazard Occupancies: 250 gpm (15.75 L/s) for 60 to 90 minutes.

C. Seismic Performance: Fire-suppression piping shall be capable of withstanding the effects of earthquake motions determined according to NFPA 13 and ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."

1.6 SUBMITTALS:

A. Product Data: For the following:
1. Piping materials and sprinkler specialty fittings.
2. Pipe hangers and supports, including seismic restraints.
3. Valves, including listed fire-protection valves, unlisted general-duty valves, and specialty valves and trim.
4. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other pertinent data.
5. Alarm devices, including electrical data.

B. Shop Drawings - General Submittal Requirements:
1. Shop Drawings shall be prepared by persons with the following qualifications:
   a. Trained and certified by manufacturer in fire suppression system design.
   b. Professional engineering license in Fire Protection or related field.

C. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations, if applicable.

D. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13 and NFPA 14. Include "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping."
E. Welding certificates.
F. Field quality-control test reports.

1.7 QUALITY ASSURANCE:

A. Installer Qualifications:
   1. Installer's responsibilities include designing, fabricating, and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
      a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
      b. Sprinkler working plans (shop drawings) shall be sealed by the Professional Engineer licensed in the State of Missouri and responsible for design oversight.
B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
C. NFPA Standards: Fire-suppression-system equipment, specialties, accessories, installation, and testing shall comply with the following:
   1. NFPA 13, "Installation of Sprinkler Systems."
   2. NFPA 20, "Installation of Stationary Fire Pumps for Fire Protection."

1.8 COORDINATION:

A. Coordination Drawings: The contractor shall prepare BIM generated overall coordination drawings to coordinate fire alarm system installation with other trades.
B. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.9 CLOSE OUT SUBMITTALS:

A. Drawings shall be furnished in electronic-media (CD-Rewritable type) and hard copy prints.
B. Operation and Maintenance Data: For fire sprinkler 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 product data for all components, testing reports.

1.10 EXTRA MATERIALS:

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Sprinkler Cabinets: Finished, wall-mounting, steel cabinet with hinged cover, with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrenches for each type of sprinkler on project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified. Alternatives must be approved prior to bidding.

2.2 STEEL PIPE AND FITTINGS:

A. Threaded-End, Standard-Weight Steel Pipe: ASTM A 135, or ASTM A 795, with factory- or field-formed threaded ends.
   1. Cast-Iron Threaded Flanges: ASME B16.1.
   2. Malleable-Iron Threaded Fittings: ASME B16.3.
   3. Gray-Iron Threaded Fittings: ASME B16.4.
   4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe. Include ends matching joining method.
   5. Steel Threaded Couplings: ASTM A 865 steel pipe where indicated.

B. Grooved-End, Standard-Weight Steel Pipe: ASTM A 135, or ASTM A 795, and with factory- or field-formed, square-cut- or roll grooved ends.
   1. Grooved-Joint Piping Systems:
      a. Manufacturers:
         1) Anvil International, Inc.
         2) Central Sprinkler Corp.
         3) National Fittings, Ltd.
         4) Southwestern Pipe, Inc.
         5) Victaulic Co. of America.
      b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
      c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, pre-lubricated rubber gasket listed for use with housing, and steel bolts and nuts.

2.3 DIELECTRIC FITTINGS:

A. Assembly shall be copper alloy, ferrous, and insulating materials with ends matching piping system.

B. Dielectric Flanges: Factory-fabricated companion-flange assembly, for 175-psig (1200-kPa) minimum or 250-psig (1725-kPa) minimum working-pressure rating as required for piping system.
   1. Manufacturers:
      a. Capitol Manufacturing Co.
      b. Central Plastics Company.
      c. Epco Sales, Inc.
      d. Watts Industries, Inc.; Water Products Div.
      e. Victaulic Co. of America

C. Dielectric Flange Insulation Kits: Components for field assembly shall include CR or phenolic gasket, PE or phenolic bolt sleeves, phenolic washers, and steel backing washers.

1. Manufacturers:
   a. Advance Products and Systems, Inc.
   b. Calpico, Inc.
   c. Central Plastics Company.
   d. Pipeline Seal and Insulator, Inc.
   e. Victaulic Co. of American

D. Dielectric Nipples: Electroplated steel with inert and noncorrosive thermoplastic lining, with combination of plain, threaded, or grooved ends and 300-psig (2070-kPa) working-pressure rating at 225 deg F (107 deg C).
1. Manufacturers:
   a. Perfection Corporation.
   b. Precision Plumbing Products, Inc.
   c. Victaulic Co. of America.

2.4 SPRINKLER SPECIALTY FITTINGS:

A. Sprinkler specialty fittings shall be UL listed or FMG approved, with 175-psig (1200-kPa) minimum working-pressure rating and made of materials compatible with piping. Sprinkler specialty fittings shall have 250-psig (1725-kPa) minimum working-pressure rating if fittings are components of high-pressure piping system. All outlets should be strapped or bolted design. Strapless outlets, similar to Victaulic style 923 are not permitted by MU.

B. Outlet Specialty Fittings:
1. Manufacturers:
   a. Anvil International, Inc.
   b. Central Sprinkler Corp.
   c. Star Pipe Products; Star Fittings Div.
   d. Victaulic Co. of America.
   e. Ward Manufacturing.
2. Mechanical-T and -Cross Fittings: UL 213, ductile-iron housing with gaskets, bolts and nuts, and threaded, locking-lug, or grooved outlets.

C. Sprinkler Drain and Alarm Test Fittings: Cast- or ductile-iron body; with threaded or locking-lug inlet and outlet, test valve, and orifice and sight glass.
1. Manufacturers:
   a. Central Sprinkler Corp.
   b. Fire-End and Croker Corp.
   c. Viking Corp.
   d. Victaulic Co. of America.

D. Sprinkler Branch-Line Test Fittings: Brass body with threaded inlet, capped drain outlet, and threaded outlet for sprinkler.
1. Manufacturers:
   a. Elkhart Brass Mfg. Co., Inc.
   b. Fire-End and Croker Corp.
   c. Potter-Roemer; Fire-Protection Div.

E. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.
1. Manufacturers:
   a. AGF Manufacturing Co.
   b. Central Sprinkler Corp.

c. G/J Innovations, Inc.
d. Triple R Specialty of Ajax, Inc.

F. Sprinkler Flex Fittings: Not permitted

2.5 LISTED FIRE-PROTECTION VALVES:

A. Valves shall be UL listed or FMG approved, with 175-psig (1200 kPa) minimum pressure rating. Valves shall have 250-psig (1725-kPa) minimum pressure rating if valves are components of high-pressure piping system.

B. Ball Valves: Comply with UL 1091, except with ball instead of disc.
1. NPS 1-1/2 (DN 40) and Smaller: Bronze body with threaded ends.
2. NPS 2 and NPS 2-1/2 (DN 50 and DN 65): Bronze body with threaded ends or ductile-iron body with grooved ends.
3. NPS 3 (DN 80): Ductile-iron body with grooved ends.
4. Manufacturers:
a. NIBCO.
b. Victaulic Co. of America.

C. Butterfly Valves: UL 1091.
1. NPS 2 (DN 50) and Smaller: Bronze body with threaded ends.
a. Manufacturers:
1) Global Safety Products, Inc.
2) Milwaukee Valve Company.
2. NPS 2-1/2 (DN 65) and Larger: Bronze, cast-iron, or ductile-iron body; wafer type or with flanged or grooved ends.
a. Manufacturers:
1) Central Sprinkler Corp.
2) Global Safety Products, Inc.
3) McWane, Inc.; Kennedy Valve Div.
4) Mueller Company.
5) NIBCO.
6) Pratt, Henry Company.
7) Victaulic Co. of America.

D. Check Valves NPS 2 (DN 50) and Larger: UL 312, swing type, cast-iron body with flanged or grooved ends.
1. Manufacturers:
a. Ames Central Sprinkler Corp.
b. Firematic Sprinkler Devices, Inc.
c. Grinnell Fire Protection.
d. Mueller Company.
e. NIBCO.
f. Potter-Roemer; Fire Protection Div.
g. Reliable Automatic Sprinkler Co., Inc.
h. Victaulic Co. of America.
i. Watts Industries, Inc.; Water Products Div.

E. Gate Valves: UL 262, OS&Y type.
1. NPS 2 (DN 50) and Smaller: Bronze body with threaded ends.
a. Manufacturers:
1) Crane Co.; Crane Valve Group; Crane Valves.

2) Hammond Valve.
3) NIBCO.
4) United Brass Works, Inc.

2. NPS 2-1/2 (DN 65) and Larger: Cast-iron body with flanged ends.
   a. Manufacturers:
      1) Crane Co.; Crane Valve Group; Crane Valves.
      2) Crane Co.; Crane Valve Group; Jenkins Valves.
      3) Hammond Valve.
      4) Milwaukee Valve Company.
      5) Mueller Company.
      6) NIBCO.
      7) Red-White Valve Corp.
      8) United Brass Works, Inc.

F. Pressure Regulating Valves – UL 1468, brass or bronze, size as needed for preaction fire sprinkler system, 400-psig minimum rating. Include female FPS inlet and outlet, adjustable setting feature, and straight or 90-degree-angle pattern design as necessary.
   1. Finish: Rough metal.
   2. Manufacturers:
      a. AFAC Inc.
      b. Elkhart Brass Mfg. Co., Inc.
      c. GRM International Equipment Corporation.
      d. Grinnell Fire Protection.
      e. Potter-Roemer; Fire Protection Division.
      f. Victaulic Co of America.
      g. Zurn Industries, Inc.; Wilkins Divison.

G. Indicating Valves: UL 1091, with integral indicating device and ends matching connecting piping.
   1. Indicator: Electrical, 115-V ac, prewired, single-circuit, supervisory switch.
   2. NPS 2 (DN 50) and Smaller: Ball or butterfly valve with bronze body and threaded ends.
      a. Manufacturers:
         1) Milwaukee Valve Company.
         2) NIBCO.
         3) Victaulic Co. of America.
   3. NPS 2-1/2 (DN 65) and Larger: Butterfly valve with cast- or ductile-iron body; wafer type or with flanged or grooved ends.
      a. Manufacturers:
         1) Central Sprinkler Corp.
         2) Grinnell Fire Protection.
         3) McWane, Inc.; Kennedy Valve Div.
         4) Milwaukee Valve Company.
         5) NIBCO.
         6) Victaulic Co. of America.

2.6 SPECIALTY VALVES:

A. Sprinkler System Control Valves: UL listed or FMG approved, cast- or ductile-iron body with flanged or grooved ends, and 175-psig (1200-kPa) minimum pressure rating. Control valves shall

have 250-psig (1725-kPa) minimum pressure rating if valves are components of high-pressure piping system.

1. Manufacturers:
   a. AFAC Inc.
   b. Central Sprinkler Corp.
   c. Firematic Sprinkler Devices, Inc.
   d. Globe Fire Sprinkler Corporation.
   e. Grinnell Fire Protection.
   f. Reliable Automatic Sprinkler Co., Inc.
   g. Star Sprinkler Inc.
   h. Venus Fire Protection, Ltd.
   i. Victaulic Co. of America.
   j. Viking Corp.

B. Automatic Drain Valves: UL 1726, NPS 3/4 (DN 20), ball-check device with threaded ends.

1. Manufacturers:
   a. AFAC Inc.
   b. Grinnell Fire Protection.

2.7 SPRINKLERS:

A. Sprinklers shall be UL listed or FMG approved, with 175-psig (1200-kPa) minimum pressure rating. Sprinklers shall have 250-psig (1725-kPa) minimum pressure rating if sprinklers are components of high-pressure piping system.

B. Manufacturers:
1. AFAC Inc.
2. Central Sprinkler Corp.
3. Grinnell Fire Protection.
4. Reliable Automatic Sprinkler Co., Inc.
5. Star Sprinkler Inc.
6. Tyco – Simplex/Grinnell
7. Victaulic Co. of America.
8. Viking Corp.

C. Automatic Sprinklers: With heat-responsive element complying with the following:
1. UL 199, for nonresidential applications.

D. Sprinkler Types and Categories: Nominal 1/2-inch (12.7-mm) orifice for Light” and “"Ordinary" temperature classification rating, unless otherwise indicated or required by application. Provide High Temperature sprinklers near heat producing appliances.

E. Sprinkler types, features, and options as follows:
1. Extended-coverage sprinklers.
2. Concealer-type sprinklers with white concealer cover plates.
3. Flush ceiling sprinklers, including escutcheon.
4. Institutional (tamper-proof) sprinklers.
5. Pendent sprinklers.
6. Pendent, dry-type sprinklers.
7. Quick-response sprinklers.
8. Recessed sprinklers, including escutcheon.
9. Sidewall sprinklers.
10. Sidewall, dry-type sprinklers.

11. Upright sprinklers.
12. Window Sprinklers.

F. Sprinkler Finishes: Chrome plated, bronze, and painted.

G. Special Coatings: Corrosion-resistant paint.

H. 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: Concealer type fire sprinklers with white concealer cover plates.
2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

I. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler.

2.8 ALARM DEVICES:

A. Alarm-device types shall match piping and equipment connections.

B. Electrically Operated Alarm: UL 464, with 6-inch- (150-mm-) minimum- 8-inch- (200-mm-) minimum- 10-inch- (250-mm-) diameter, vibrating-type, metal alarm bell with red-enamel factory finish and suitable for outdoor use.
1. Manufacturers:
a. Potter Electric Signal Company.
b. System Sensor.

C. Water-Flow Indicator: UL 346, electrical-supervision, paddle-operated-type, water-flow detector with 250-psig (1725-kPa) pressure rating and designed for horizontal or vertical installation. Include two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
1. Manufacturers:
a. Grinnell Fire Protection.
b. ITT McDonnell & Miller.
c. Potter Electric Signal Company.
d. System Sensor.
e. Viking Corp.
f. Watts Industries, Inc.; Water Products Div.

D. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.
1. Manufacturers:
a. McWane, Inc.; Kennedy Valve Div.
b. Potter Electric Signal Company.
c. System Sensor.

2.9 PRESSURE GAGES:

A. Manufacturers:
1. AGF Manufacturing Co.
2. AMETEK, Inc.; U.S. Gauge.
3. Brecco Corporation.
4. Dresser Equipment Group; Instrument Div.
5. Marsh Bellofram.
6. WIKA Instrument Corporation.

B. Description: UL 393, 3-1/2- to 4-1/2-inch- (90- to 115-mm-) diameter, dial pressure gage with range of 0 to 250 psig (0 to 1725 kPa) minimum.
   1. Water System Piping: Include caption "WATER" on dial face.

2.10 AUTOMATIC AIR RELEASE VALVE:

A. Manufacturers:
   1. Cla-Val
   2. Potter
   3. Viking
   4. Watts

B. Description: UL 2573, Epoxy Coated Ductile Iron ASTM A536 65-45-12; Epoxy Coated Cast Steel ASTM A 216WCB, or Brass -- High performance air release and vacuum breaker valve. Provide ball valve and strainer.

PART 3 - EXECUTION

3.1 PREPARATION:

A. Use results of fire hydrant flow test for system design calculations required in Part 1 "Quality Assurance" Article. Fire hydrant testing is provided by MU Energy Management.

B. Fire Sprinkler contractors shall provide complete flush of underground fire sprinkler system prior to connection of interior pipe to underground pipe.

3.2 EXAMINATION:

A. Examine roughing-in for hose connections to verify actual locations of piping connections before installation.

B. Examine walls and partitions for suitable thicknesses, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.

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

3.3 PIPING APPLICATIONS, GENERAL:

A. Shop weld pipe joints where welded piping is indicated.

B. Flanges, flanged fittings, unions, nipples, and transition and special fittings with finish and pressure ratings same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.

3.4 SPRINKLER SYSTEM PIPING APPLICATIONS:

A. Standard-Pressure, Wet-Pipe Sprinkler System, 250-psig (1725-kPa) Maximum Working Pressure:
   1. 2” and smaller: Threaded-end, black, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints or standard-weight steel pipe and grooved ends and grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
   2. 2-1/4” and larger: Threaded-end, black, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints or standard-weight steel pipe and grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

3. Victaulic FireLock™, Innovative Groove System (IGS) with installation ready fittings and couplings may be used for NPS 1 (DN 25). System rated for working pressure to 365 psi (2517 kPa).
4. Sprinkler-Piping Fitting Option: Specialty sprinkler fittings, NPS 2 (DN 50) and smaller, including mechanical-T and -cross fittings, may be used downstream from sprinkler zone valves.

3.5 VALVE APPLICATIONS:

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Listed Fire-Protection Valves: UL listed or FMG approved for applications where required by NFPA 13 and NFPA 14.
      a. Shutoff Duty: Use ball, butterfly, or gate valves.
   2. Unlisted General-Duty Valves: For applications where UL-listed or FMG-approved valves are not required by NFPA 13 and NFPA 14.
      a. Shutoff Duty: Use ball, butterfly, or gate valves.
      b. Throttling Duty: Use ball or globe valves.

3.6 JOINT CONSTRUCTION:

A. Threaded Joints: Comply with NFPA 13 for pipe thickness and threads.
B. Grooved Joints: Assemble joints with listed coupling and gasket, lubricant, and bolts.
   1. Ductile-Iron Pipe: Radius-cut-groove ends of piping. Use grooved-end fittings and grooved-end-pipe couplings.
   2. Steel Pipe: Square-cut or roll-groove piping as indicated. Use grooved-end fittings and rigid, grooved-end-pipe couplings, unless otherwise indicated.

3.7 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.
B. Sprinkler piping shall be installed parallel or perpendicular to building elements, and in line with other MEP system piping or conduit.
C. Install pipe with weld line rotated at least 45° in relationship to the floor (for reference, the weld line points at the floor at 0°) to help reduce the potential for accelerated internal pipe corrosion of longitudinally-welded black steel sprinkler system pipe in accordance with FM Data Sheet 2-0 Section 2.4.1.1.5.2.
D. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
E. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.
F. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger connections.
G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13.
H. Install sprinkler piping with drains for complete system drainage.
I. Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.
J. Install alarm devices in piping systems.

K. Hangers and Supports: Comply with NFPA 13 for hanger materials.
   1. Install sprinkler piping system according to NFPA 13.
L. Fill wet-pipe sprinkler system piping with water.

3.8 VALVE INSTALLATION:
A. Install listed fire-protection valves, unlisted general-duty valves, specialty valves and trim, controls, and specialties according to NFPA 13 and NFPA 14 and authorities having jurisdiction.
B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire department connections. Install permanent identification signs indicating portion of system controlled by each valve.
C. Valves for Wall-Type Fire Hydrants: Install non-rising-stem gate valve in water-supply pipe.
D. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water supply sources.

3.9 SPRINKLER APPLICATIONS:
A. Drawings indicate sprinkler types to be used. Where specific types are not indicated, use the following sprinkler types:
   1. Rooms without Ceilings: Upright brass sprinklers.
   2. Rooms with Suspended Ceilings: Concealed brass sprinklers with white cover plates. Provide special color as indicated.
   3. Rooms with Gypsum Board Ceilings: Concealed brass sprinklers with white cover plates.
   4. Wall Mounting: Sidewall sprinklers.
   5. Spaces Subject to Freezing: Upright, pendent, dry sprinklers; and sidewall, dry sprinklers as required.
   6. Special Applications: Extended-coverage, and quick-response sprinklerswhere required. UL listed Quick Response concealed sprinklers can be used in accordance with FMG approval for Ordinary Response applications throughout the facility.
   7. Sprinkler Finishes:
      a. Upright, rough bronze in unfinished spaces not exposed to view.
      b. Sidewall Sprinklers: Chrome color coated in finished spaces exposed to view.
      c. Concealed Sprinklers: Brass with white cover plate.
      d. Pendent Sprinklers: Chrome with chrome escutcheons.

3.10 SPRINKLER INSTALLATION:
A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels and tiles.
B. Sprinklers shall be installed in line with architectural elements, lights, diffusers, etc. Sprinkler shall be installed symmetrically around structural members and in compliance with NFPA 13.
C. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space.

3.11 CONNECTIONS:
A. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to equipment to allow service and maintenance in accordance with MU Design Guidelines (24” around all valves) and NFPA 13/14 (36 inches working clearance in front of equipment)

C. Install ball drip valves at each check valve for fire department connection. Drain to floor drain or outside building.
D. Connect piping to specialty valves, hose valves, specialties, fire department connections, and accessories.
E. Electrical Connections: Power wiring is specified in DIVISION 26.
F. Connect alarm devices to fire alarm.
G. Ground equipment according to DIVISION 26 SECTION "GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS."
H. Connect wiring according to DIVISION 26 SECTION "LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES."
I. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.12 LABELING AND IDENTIFICATION:
A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

3.13 FIELD QUALITY CONTROL:
A. Perform the following field tests and inspections and prepare test reports:
1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
2. Energize circuits to electrical equipment and devices.
3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
4. Coordinate with fire alarm tests. Operate as required.
5. Coordinate with fire-pump tests. Operate as required.
6. Verify that equipment hose threads are same as local fire department equipment.
B. Report test results promptly and in writing to Architect and authorities having jurisdiction.

3.14 CLEANING AND PROTECTION:
A. Clean dirt and debris from sprinklers.
B. Remove and replace sprinklers with paint other than factory finish.
C. Protect sprinklers from damage until Substantial Completion.

3.15 DEMONSTRATION:
A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

END OF SECTION 21 13 13

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SECTION 21 13 16 - DRY-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY:

A. SECTION Includes:
   1. Pipes, fittings, and specialties.
   2. Fire-protection valves.
   3. Fire-department connections.
   4. Sprinkler specialty pipe fittings.
   5. Sprinklers.
   6. Alarm devices.
   7. Pressure gages.
   8. Nitrogen Corrosion Inhibiting System.

B. Related Sections:
   1. SECTION 21 13 13 "WET PIPE SPRINKLER SYSTEMS" for sprinkler and standpipe piping.
   2. SECTION 28 30 11 "DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM" for alarm devices not specified in this SECTION.

1.02 DEFINITIONS:

A. High-Pressure Piping System: Fire-suppression piping system designed to operate at working pressure higher than standard 175 psig (1200 kPa).

B. Listed: Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services. In accordance with NFPA all equipment, materials or services shall be listed by an approval agency including the following – UL, FM or other acceptable agencies. This project is insured by FM Global and it is desirable to utilize equipment that is listed in the Factory Mutual approval guide. UL standards are included as a basis-of-design.

1.03 SYSTEM DESCRIPTIONS:

A. Single Interlock Pre-action System: Automatic sprinklers are attached to piping containing air. Actuation of fire-detection system in same area as sprinklers opens deluge valve, permitting water to flow into piping and to discharge from sprinklers that have opened. Two smoke detectors are required for actuating valve. Fire alarm contractor to provide all fire alarm devices.

1.04 PERFORMANCE REQUIREMENTS:

A. Standard-Pressure Piping System Component: Listed for 175-psig (1200-kPa) minimum working pressure.

B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

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. Imaging Equipment Rooms and associated spaces.
      b. General Storage: Ordnary Hazard, Group 2.
      c. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
   3. Minimum Density for Automatic-Sprinkler Piping Design:

a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. (4.1 mm/min. over 139-sq. m) area plus 30% increase in design area per NFPA 13.
b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. (6.1 mm/min. over 139-sq. m) area plus 30% increase in design area per NFPA 13.
c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. (8.1 mm/min. over 139-sq. m) area plus 30% increase in design area per NFPA 13.

4. Maximum Protection Area per Sprinkler: Per UL listing.
5. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated:
   a. Light-Hazard Occupancies: 100 gpm (6.3 L/s) for 30 minutes.
   b. Ordinary-Hazard Occupancies: 250 gpm (15.75 L/s) for 60 to 90 minutes.

D. Seismic Performance: Fire-suppression piping shall be capable of withstanding the effects of earthquake motions determined according to NFPA 13 and ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."

1.05 SUBMITTALS:

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

1. Piping materials, including dielectric fittings and sprinkler specialty fittings.
2. Pipe hangers and supports, including seismic restraints.
3. Valves, including listed fire-protection valves, unlisted general-duty valves, and specialty valves and trim.
4. Air compressors and Nitrogen generators, including electrical data.
5. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other pertinent data.
6. Alarm devices, including electrical data.

B. Shop Drawings: For dry-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.
   1. Wiring Diagrams: For power, signal, and control wiring.

C. 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.

D. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

E. 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."

F. Field quality-control reports.

G. Operation and maintenance data.

1.06 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. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
C. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
   1. NFPA 13, "Installation of Sprinkler Systems."

PART 2 - PRODUCTS

2.01 PIPING MATERIALS:

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.02 STEEL PIPE AND FITTINGS:

A. Schedule 40: ASTM A 135; ASTM A 795/A 795M; or ASME B36.10M, wrought steel; with wall thickness not less than Schedule 30 and not more than Schedule 40. Pipe ends may be factory or field formed to match joining method.
B. Malleable- or Ductile-Iron Unions: UL 860.
C. Cast-Iron Flanges: ASME B16.1, Class 125.
D. Grooved-Joint, Steel-Pipe Appurtenances:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Anvil International, Inc.
      b. Corcoran Piping System Co.
      c. National Fittings, Inc.
      d. Shurjoint Piping Products.
      e. Tyco Fire & Building Products LP.
      f. Victaulic Company.
   2. Pressure Rating: 175 psig (1200 kPa) minimum.
   3. Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
   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 gasket, and bolts and nuts.

2.03 PIPING JOINING MATERIALS:

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free.
   1. Class 125, Cast-Iron Flat-Face Flanges: Full-face gaskets.
B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

2.04 LISTED FIRE-PROTECTION VALVES:

A. General Requirements:
   1. Valves shall be UL listed or FM approved.
   2. Minimum Pressure Rating: 175 psig (1200 kPa).
B. Bronze OS&Y Gate Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Stockham Division.
   c. Milwaukee Valve Company.
   d. NIBCO INC.
   e. United Brass Works, Inc.
2. Standard: UL 262.
3. Pressure Rating: 175 psig (1200 kPa).
4. Body Material: Bronze.
5. End Connections: Threaded.

C. Iron OS&Y Gate Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. American Cast Iron Pipe Company; Waterous Company Subsidiary.
   b. American Valve, Inc.
   c. Crane Co.; Crane Valve Group; Crane Valves.
   d. Milwaukee Valve Company.
   e. Mueller Co.; Water Products Division.
   f. NIBCO INC.
   g. Shurjoint Piping Products.
   h. Tyco Fire & Building Products LP.
   i. United Brass Works, Inc.
   j. Watts Water Technologies, Inc.
2. Standard: UL 262.
3. Pressure Rating: 250 psig (1725 kPa) minimum.
4. Body Material: Cast or ductile iron.
5. End Connections: Flanged or grooved.

D. Indicating-Type Butterfly Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Anvil International, Inc.
   b. Fivalco Inc.
   c. Global Safety Products, Inc.
   d. Kennedy Valve; a division of McWane, Inc.
   e. Milwaukee Valve Company.
   f. NIBCO INC.
   g. Shurjoint Piping Products.
   h. Tyco Fire & Building Products LP.
   i. Victaulic Company.
2. Standard: UL 1091.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Valves NPS 2 (DN 50) and Smaller:
   a. Valve Type: Ball or butterfly.

b. Body Material: Bronze.
c. End Connections: Threaded.

5. Valves NPS 2-1/2 (DN 65) and Larger:
   a. Valve Type: Butterfly.
   b. Body Material: Cast or ductile iron.
   c. End Connections: Flanged, grooved, or wafer.
6. Valve Operation: Integral electrical, 115-V ac, prewired, single-circuit, supervisory switch and visual indicating device.

2.05 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. Minimum Pressure Rating: 175 psig (1200 kPa).

B. Ball Valves:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Affiliated Distributors.
      b. Anvil International, Inc.
      c. Conbraco Industries, Inc.; Apollo Valves.
      d. Fire-End & Croker Corporation.
      e. Kennedy Valve; a division of McWane, Inc.
      f. Milwaukee Valve Company.
      g. NIBCO INC.
      h. Potter Roemer.
      i. Tyco Fire & Building Products LP.
      j. Victaulic Company.
      k. Watts Water Technologies, Inc.

2.06 SPECIALTY VALVES:

A. General Requirements:
   1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
   2. Minimum Pressure Rating: 175 psig (1200 kPa).
   3. Body Material: Cast or ductile iron.
   4. Size: Same as connected piping.
   5. End Connections: Flanged or grooved.

B. Dry-Pipe Valves:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. AFAC Inc.
      b. Globe Fire Sprinkler Corporation.
      c. Reliable Automatic Sprinkler Co., Inc.
      d. Tyco Fire & Building Products LP.
      e. Venus Fire Protection Ltd.

f. Victaulic Company.
g. Viking Corporation.

2. Standard: UL 260
3. Design: Differential-pressure type.
4. Include UL 1486, quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

C. Pressure Regulating Valves – UL 1468, brass or bronze, size as needed for preaction fire sprinkler system, 400-psig minimum rating. Include female FPS inlet and outlet, adjustable setting feature, and straight or 90-degree-angle pattern design as necessary.
1. Finish: Rough metal.
2. Manufacturers:
a. AFAC Inc.
b. Elkhart Brass Mfg. Co., Inc.
c. GRM International Equipment Corporation.
d. Grinnell Fire Protection.
e. Potter-Roemer; Fire Protection Division.
f. Victaulic Co of America.
g. Zurn Industries, Inc.; Wilkins Divison.

2.07 SPRINKLER SPECIALTY PIPE FITTINGS:

A. General Requirements for Dry-Pipe-System Fittings: UL listed for dry-pipe service.
B. Branch Outlet Fittings:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Anvil International, Inc.
b. National Fittings, Inc.
c. Shurjoint Piping Products.
d. Tyco Fire & Building Products LP.
e. Victaulic Company.
2. Standard: UL 213.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
5. Type: Mechanical-T and -cross fittings.
6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
8. Branch Outlets: Grooved, plain-end pipe, or threaded.
C. Flow Detection and Test Assemblies:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. AGF Manufacturing Inc.
b. Reliable Automatic Sprinkler Co., Inc.
c. Tyco Fire & Building Products LP.

d. Victaulic Company.

2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

D. Branch Line Testers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Elkhart Brass Mfg. Company, Inc.
   b. Fire-End & Croker Corporation.
   c. Potter Roemer.
2. Standard: UL 199.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Body Material: Brass.
5. Size: Same as connected piping.
6. Inlet: Threaded.
7. Drain Outlet: Threaded and capped.
8. Branch Outlet: Threaded, for sprinkler.

E. Sprinkler Inspector's Test Fittings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. AGF Manufacturing Inc.
   b. Triple R Specialty.
   c. Tyco Fire & Building Products LP.
   d. Victaulic Company.
   e. Viking Corporation.
2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Body Material: Cast- or ductile-iron housing with sight glass.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

F. Nitrogen Corrosion Inhibiting System

1. Available Manufacturers:
   a. N-2 Blast by South-Tek Systems
   b. ECS Protector by Engineered Corrosion Solutions
   c. MICBlast by National Fire Equipment, Ltd.
2. Description: Engineered UL listed corrosion inhibiting system by introducing Nitrogen and deoxyginated air into piping with separate air compressor as needed to meet 30- minute NFPA 13 fill requirements and integral Nitrogen Storage tanks.

2.08 SPRINKLERS:

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. AFAC Inc.
   2. Globe Fire Sprinkler Corporation.
   3. Reliable Automatic Sprinkler Co., Inc.
   4. Tyco Fire & Building Products LP.
   5. Venus Fire Protection Ltd.
   6. Victaulic Company.
   7. 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 Automatic Sprinklers: 175 psig (1200 kPa) minimum.

C. Automatic Sprinklers with Heat-Responsive Element:
   1. Nonresidential Applications: UL 199.
   2. Characteristics: Nominal 1/2-inch (12.7-mm) orifice with discharge coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

D. Sprinkler Finishes:
   1. Chrome plated.
   2. Bronze.
   3. Painted.

E. Special Coatings:
   1. Corrosion-resistant paint.

F. 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, two-piece, with 1-inch (25-mm) vertical adjustment.
   2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

G. Sprinkler Guards:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Reliable Automatic Sprinkler Co., Inc.
      b. Tyco Fire & Building Products LP.
      c. Victaulic Company.
      d. Viking Corporation.
   2. Standard: UL 199.
   3. Type: Wire cage with fastening device for attaching to sprinkler.

2.09 ALARM DEVICES:

A. Alarm-device types shall match piping and equipment connections. Pre- Action fire alarm devices provided and installed by fire alarm contractor.

B. Valve Supervisory Switches:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Fire-Lite Alarms; a Honeywell company.
   b. Kennedy Valve; a division of McWane, Inc.
   c. Potter Electric Signal Company.
   d. System Sensor; a Honeywell company.
2. Standard: UL 346.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled valve is in other than fully open position.

C. Pressure Switches:
1. Manufacturers:
   a. Potter Electric Signal Co.
   b. System Sensor
   c. Tyco by Johnson Controls
   d. Viking Corporation
2. Standard: UL 346.
3. Type: Electrically supervised water-flow switch with retard feature.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design Operation: Rising pressure signals water flow.

D. Smoke Detection:
1. All detection devices for Pre-Action system shall be provided by Fire Alarm contractor, wired by fire alarm contractor and coordinated with Fire Sprinkler contractor.

2.10 PRESSURE GAGES:

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. AMETEK, Inc.; U.S. Gauge Division.
2. Ashcroft, Inc.
3. Brecco Corporation.
4. WIKA Instrument Corporation.

B. Standard: UL 393.
C. Dial Size: 3-1/2- to 4-1/2-inch (90- to 115-mm) diameter.
D. Pressure Gage Range: 0 to 250 psig (0 to 1725 kPa) minimum 0 to 300 psig (0 to 2070 kPa).
E. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.
F. Air System Piping Gage: Include retard feature and "AIR" or "AIR/WATER" label on dial face.

2.11 ESCUTCHEONS:

A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.
B. One-Piece, Cast-Brass Escutcheons: Polished chrome-plated or rough-brass finish with set-screws.
C. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with chrome-plated finish.
D. One-Piece, Stamped-Steel Escutcheons: Chrome-plated finish with set-screw or spring clips.
E. Split-Casting, Cast-Brass Escutcheons: Polished chrome-plated or rough-brass finish with concealed hinge and set-screw.

F. Split-Plate, Stamped-Steel Escutcheons: Chrome-plated finish with concealed exposed-rivet hinge, set-screw or spring clips.
G. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
H. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.12 SLEEVES:
A. Cast-Iron Wall Pipe Sleeves: Cast or fabricated of cast iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
B. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
C. Molded-PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
D. Molded-PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.
E. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
F. Sleeves: ASTM A 53/A 53M, Type E, standard weight, zinc coated, plain ends.
G. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
1. Underdeck Clamp: Clamping ring with set-screws.

2.13 SLEEVE SEALS:
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. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex, Inc.
4. Pipeline Seal and Insulator, Inc.
B. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
1. Sealing Elements: EPDM-rubber or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: arbon steel Plastic Stainless steel.
3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating Stainless steel of length required to secure pressure plates to sealing elements.

2.14 GROUT:
A. Standard: ASTM C 1107, Grade B, post-hardening and volume adjusting, dry, hydraulic-cement grout.
B. Characteristics: Non-shrink, and recommended for interior and exterior applications.
C. Design Mix: 5000-psi (34-MPa), 28-day compressive strength.
D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.01 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.
B. Piping Standard: Comply with requirements in NFPA 13 for installation of sprinkler piping.

C. Install pipe with weld line rotated at least 45° in relationship to the floor (for reference, the weld line points at the floor at 0°) to help reduce the potential for accelerated internal pipe corrosion of longitudinally-welded black steel sprinkler system pipe in accordance with FM Data Sheet 2-0 Section 2.4.1.1.5.2.
D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
E. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
H. Install sprinkler piping with drains for complete system drainage.
I. Install alarm devices in piping systems.
J. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements in NFPA 13 for hanger materials.
K. Drain dry-pipe sprinkler piping.
L. Pressurize and check dry-pipe and pre-action sprinkler system piping and Nitrogen Corrosion Inhibiting System. Adjust Nitrogen in system to acceptable levels.

3.02 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 (DN 50) and smaller.
C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) 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. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

3.03 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. Coordinate with Fire Alarm contractor for Pre-Action system operation.

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. Specialty Valves:
   1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
   2. Dry-Pipe Valves: Install trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
      a. Install air compressor and compressed-air supply piping.
      b. Install Nitrogen Generator.
   3. Pressure Regulating Valves: Install at Preaction system connection to wet pipe system.

3.04 SPRINKLER INSTALLATION:

A. Install sprinklers in suspended ceilings incenter of narrowdimension 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.

3.05 ESCUTCHEON INSTALLATION:

A. Install escutcheons for penetrations of walls, ceilings, and floors.

B. Escutcheons for New Piping:
   1. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
   2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish, stamped steel with set-screw, stamped steel with set-screw or spring clips, stamped steel with spring clips.
   3. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast brass with polished chrome-plated finish,One-piece or split casting, cast brass with polished chrome-plated finish, Split casting, cast brass with polished chrome-plated finish One- piece, stamped steel with set-screw, One piece or split plate, stamped steel with set-screw, Split plate, stamped steel with set-screw.
   4. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish, cast brass with rough-brass finish, stamped steel with set-screw, stamped steel with spring clips, stamped steel with set-screw or spring clips.
   5. Bare Piping in Equipment Rooms: One piece, cast brass, stamped steel with set-screw, stamped steel with spring clips, stamped steel with set-screw or spring clips.
   6. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

3.06 SLEEVE INSTALLATION:

A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.

B. Sleeves are not required for core-drilled holes.

C. Permanent sleeves are not required for holes formed by removable PE sleeves.

D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.

E. Install sleeves in new partitions, slabs, and walls as they are built.

F. For interior wall penetrations, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in DIVISION 07 SECTION "JOINT SEALANTS".

G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in DIVISION 07 SECTION "JOINT SEALANTS".
H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals.
I. Seal space outside of sleeves in concrete slabs and walls with grout.
J. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe unless otherwise indicated.
K. Install sleeve materials according to the following applications:
    1. Sleeves for Piping Passing through Gypsum-Board Partitions:
        a. PVC-pipe sleeves for pipes smaller than NPS 6 (DN 150).
        b. Galvanized-steel-sheet sleeves for pipes NPS 6 (DN 150) and larger.
        c. Exception: Sleeves are not required for water-supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.
    2. Sleeves for Piping Passing through Interior Concrete Walls:
        a. PVC-pipe sleeves for pipes smaller than NPS 6 (DN 150).
        b. Galvanized-steel-sheet sleeves for pipes NPS 6 (DN 150) and larger.
L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in DIVISION 07 SECTION "PENETRATION FIRESTOPPING" for firestop materials and installations.

3.07 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.

3.08 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. Charge Nitrogen Corrosion Inhibiting System.
    6. Coordinate with fire-alarm tests. Operate as required.
C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
D. Prepare test and inspection reports.

3.09 CLEANING:
A. Clean dirt and debris from sprinklers.
B. Remove and replace sprinklers with paint other than factory finish.

3.10 PIPING SCHEDULE:

A. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.

B. Dry-pipe and Pre-Action sprinkler system, NPS 2 (DN 50) and smaller, shall be one of the following:
   1. Standard-weight with threaded ends; gray-iron threaded fittings; and threaded joints.
   2. Standard-weight with grooved ends; grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

C. Dry-pipe and Pre-Action sprinkler system, NPS 2-1/2 to NPS 6 (DN 65 to DN 150), shall be one of the following:
   1. Standard-weight with threaded ends; gray-iron threaded fittings; and threaded joints.
   2. Standard-weight with grooved ends; grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.11 SPRINKLER SCHEDULE:

A. Use sprinkler types in subparagraphs below for the following applications:
   1. Rooms without Ceilings: Upright sprinklers.
   2. Rooms with Suspended Ceilings: Dry pendent, recessed, flush, and concealed sprinklers, as indicated.
   3. Wall Mounting: Dry sidewall sprinklers.
   4. Special Applications: Extended-coverage and quick-response sprinklers where indicated.

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. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
   4. Upright, Pendent, and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view.

END OF SECTION 21 13 16

SECTION 22 05 18 – ESCUTCHEONS FOR PLUMBING 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.

1.02 SUMMARY:

A. This SECTION includes:
   1. Escutcheons.

1.03 SUBMITTALS:

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

PART 2 - PRODUCTS

2.01 ESCUTCHEONS:

A. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
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 and exposed-rivet hinge, and spring-clip fasteners.
D. One-Piece, Cast-Brass Type: With polished, chrome-plated or rough-brass finish.

2.2 EXECUTION

2.02 INSTALLATION:

A. Install escutcheons for piping penetrations of walls and ceilings.
B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.
   1. Escutcheons for New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
      c. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge with spring clips.
      d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type, chrome-plated finish or split-plate, stamped-steel type with concealed hinge.
      e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type, chrome-plated finish or split-plate, stamped-steel type with concealed hinge.
      f. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
      g. Bare Piping in Equipment Rooms: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.

2.03 FIELD QUALITY CONTROL:

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 22 05 18

SECTION 22 05 19 – METERS AND GAGES FOR PLUMBING 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.

1.02 SUMMARY:

A. SECTION Includes:
   1. Liquid-in-glass thermometers.
   2. Thermowells.
   3. Dial-type pressure gages.
   4. Gage attachments.
   5. Test plugs.
   6. Test-plug kits.

1.03 RELATED REQUIREMENTS:

1. DIVISION 21 FIRE-SUPPRESSION PIPING Sections for fire-protection pressure gages.
2. DIVISION 33 – WATER DISTRIBUTION PIPING for domestic water meters and combined domestic and fire-protection water-service meters outside the building.
3. SECTION 22 11 16 – DOMESTIC WATER PIPING for water meters inside the building.

1.04 REFERENCE STANDARDS:

A. Applicable Standards (Latest Edition):
   1. ASME International (ASME):
      a. ASME B1.1 - Unified Inch Screw Threads, UN and UNR Thread Form.
      b. ASME B1.20.1 - Pipe Threads, General Purpose, Inch.
      c. ASME B40.100 - Pressure Gauges and Gauge Attachments.
      d. ASME B40.200 - Thermometers, Direct Reading and Remote Reading.

1.05 SUBMITTALS:

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

PART 2 - PRODUCTS

2.01 LIQUID-IN-GLASS THERMOMETERS:

A. Plastic-Case, Industrial-Style, Liquid-in-Glass Thermometers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ernst Flow Industries.
      b. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
      c. Weiss Instruments, Inc.
      d. WIKA Instrument Corporation - USA.
   2. Standard: ASME B40.200.
   3. Case: Plastic; 7-inch (178-mm) nominal size, unless otherwise indicated.

4. Case Form: Adjustable angle, unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue or red organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in ºF (ºC).
7. Window: Glass.
8. Stem: Aluminum, brass, or stainless steel and of length to suit installation.
   a. Design for Thermowell Installation: Bare stem.
9. Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.
10. Accuracy: ±1% of scale range or one scale division, to a maximum of 1.5% of scale range.

2.02 THERMOWELLS:

A. Thermowells:
   1. Standard: ASME B40.200.
   2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
   3. Material for Use with Copper Tubing: CNR or CUNI.
   4. Material for Use with Steel Piping: CRES.
   5. Type: Stepped shank, unless straight or tapered shank is indicated.
   6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, (DN 15, DN 20, or NPS 25,) ASME B1.20.1 pipe threads.
   7. Internal Threads: 1/2, 3/4, and 1 inch (13, 19, and 25 mm), with ASME B1.1 screw threads.
   8. Bore: Diameter required to match thermometer bulb or stem.
   9. Insertion Length: Length required to match thermometer bulb or stem.
   10. Lagging Extension: Include on thermowells for insulated piping and tubing.
   11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.03 PRESSURE GAGES:

A. Direct-Mounted, Plastic-Case, Dial-Type Pressure Gages:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ashcroft, Inc.
      b. Flo Fab, Inc.
      c. Tel-Tru Manufacturing Company.
      d. Trerice, H. O. Co.
      e. Weiss Instruments, Inc.
      f. WIKA Instrument Corporation - USA.
   2. Standard: ASME B40.100.
   3. Case: Sealed type; plastic; 6-inch (152-mm) nominal diameter.
   4. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
   5. Pressure Connection: Brass, with NPS 1/2 (DN 15), ASME B1.20.1 pipe threads and bottom-outlet type, unless back-outlet type is indicated.
   6. Movement: Mechanical, with link to pressure element and connection to pointer.
   7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa).
   8. Pointer: Dark-colored metal.

9. Window: Glass.
10. Accuracy: Grade A, ±1% of middle half of scale range.

2.04 GAGE ATTACHMENTS:

A. Snubbers: ASME B40.100, brass; with NPS 1/2 (DN 15), ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.
B. Valves: Brass ball, with NPS 1/2 (DN 15), ASME B1.20.1 pipe threads.

2.05 TEST PLUGS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. National Meter, Inc.
   2. Peterson Equipment Co., Inc.
   3. Trerice, H. O. Co.
   4. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
   5. Weiss Instruments, Inc.
B. Description: Test-station fitting made for insertion into piping tee fitting.
C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
D. Thread Size: NPS 1/4 (DN 8) or NPS 1/2 (DN 15), ASME B1.20.1 pipe thread.
E. Minimum Pressure and Temperature Rating: 500 psig at 200ºF (3450 kPa at 93ºC).
F. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

2.06 TEST-PLUG KITS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. National Meter, Inc.
   2. Peterson Equipment Co., Inc.
   3. Trerice, H. O. Co.
   4. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
   5. Weiss Instruments, Inc.
B. Furnish one test-plug kit 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.
C. 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 125ºF (-4 to +52ºC).
D. 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).
E. Carrying Case: Metal or plastic, with formed instrument padding.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.
B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.
E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
G. Install valve and snubber in piping for each pressure gage for fluids.
H. Install test plugs in piping tees.
I. Install thermometers in the following locations:
   1. All inlets and outlets of each domestic water heat exchanger.
   2. Each DHW and DHWR main floor level branch connection to riser.
J. Install pressure gages in the following locations:
   1. Building water service entrance into building.
   2. Downstream of each DCW and DHW main floor level branch isolation valve.
   3. Inlet and outlet of each pressure-reducing valve.
   4. Suction and discharge of each domestic water pump.
   5. Suction and discharge of each domestic circulation pump.
   6. Downstream of water softeners.
   7. Downstream of water meters.
   8. Downstream of backflow preventers.

3.02 CONNECTIONS:
A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.03 ADJUSTING:
A. Adjust faces of meters and gages to proper angle for best visibility.

3.04 THERMOMETER SCHEDULE:
A. Thermometers at inlets and outlets of each domestic water heat exchanger shall be:
   1. Industrial-style, liquid-in-glass type.
   2. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.
B. Thermometers at branch piping shall be:
   1. Industrial-style, liquid-in-glass type.
   2. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.
C. Thermometer stems shall be of length to match thermowell insertion length.

3.05 THERMOMETER SCALE-RANGE SCHEDULE:
A. Scale Range for Domestic Cold-Water Piping: 0 to 100ºF (-20 to +50ºC).
B. Scale Range for Domestic Hot-Water Piping: 0 to 250ºF (0 to 150ºC).

3.06 PRESSURE-GAGE SCHEDULE:
A. Pressure gages at discharge of each water service into building and floor level branch shall be:
   1. Sealed, direct-mounted, plastic case.
   2. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.
B. Pressure gages at each water pressure-reducing, all pumps, water softeners, water meters, and backflow preventers valve shall be:
   1. Sealed, direct-mounted, plastic case.

2. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.

C. Pressure gages at suction and discharge of each domestic water pump or circulator shall be:
   1. Sealed, direct-mounted, plastic case.
   2. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.

3.07 PRESSURE-GAGE SCALE-RANGE SCHEDULE:

A. Scale Range for Water Service Piping: 0 to 160 psi (0 to 1,100 kPa).
B. Scale Range for Domestic Water Piping: 0 to 160 psi (0 to 1,100 kPa).
C. Scale Range for Domestic Pumps and Circulators: 30 in. Hg. to 160 psi (-100 to 1,100 kPa).

END OF SECTION 22 05 19

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SECTION 22 05 23 - GENERAL-DUTY VALVES FOR PLUMBING 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.

1.02 SUMMARY:

A. This SECTION includes:
   1. Bronze ball valves.
   2. Iron lug style butterfly valves.
   3. Bronze swing check valves.
   4. Iron gate valves.
   5. Iron swing check valves.

B. Related Sections:
   1. DIVISION 22 Plumbing Piping Sections for specialty valves applicable to those sections only.
   2. SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT for valve tags and schedules.
   3. SECTION 23 09 23 – DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC for control valves.
   4. DIVISION 33 - WATER DISTRIBUTION PIPING SECTIONS for general-duty and specialty valves for site construction piping.

1.03 REFERENCE STANDARDS:

A. Applicable Standards (Latest Edition):
   1. ASME International (ASME):
      a. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).
      b. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
      c. ASME B16.10 - Face-to-Face and End-to-End Dimensions of Valves.
      d. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
      e. ASME B16.34 - Valves - Flanged, Threaded, and Welding End.
      f. ASME B31.9 - Building Services Piping.
   2. ASTM International (ASTM):
      a. ASTM A126 - Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
      b. ASTM A536 - Specification for Ductile Iron Castings.
      c. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications
   3. Manufacturers Standardization Society of The Valve and Fittings Industry, Inc. (MSS):
      a. MSS SP-45 - Bypass and Drain Connections.
      b. MSS SP-67 - Butterfly Valves.
      c. MSS SP-70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
      d. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves.
      e. MSS SP-110 - Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
   4. NSF International (NSF):
      a. NSF 61 - Drinking Water System Components - Health Effects.
      b. NSF 372 - Drinking Water System Components - Lead Content.

1.04 DEFINITIONS:
- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.
- G. SWP: Steam working pressure.

1.05 SUBMITTALS:
- A. Product Data: For each type of valve indicated.

1.06 QUALITY ASSURANCE:
- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
  1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
  2. ASME B31.9 for building services piping valves.
- C. NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.

1.07 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 and plug 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 GENERAL REQUIREMENTS FOR VALVES:
- A. Refer to valve schedule articles for applications of valves.
- B. All Plumbing Valves shall be of Lead-Free Construction
- C. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- D. Valve Sizes: Same as upstream piping, unless otherwise indicated.
- E. Valve Actuator Types:
  1. Gear Actuator: For quarter-turn valves NPS 8 (DN 200) and larger.
  2. Handwheel: For valves other than quarter-turn types.
  3. Hand lever: For quarter-turn valves NPS 6 (DN 150) and smaller.

4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

F. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:
1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: With extended neck.

G. Valve-End Connections:
1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Solder Joint: With sockets according to ASME B16.18.
3. Threaded: With threads according to ASME B1.20.1.

H. Valve Bypass and Drain Connections: MSS SP-45.

2.02 SILICON BRONZE BALL VALVES:

A. Two-Piece, Regular-Port, Silicon Bronze Ball Valves with Stainless-Steel Trim:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Conbraco Industries, Inc.; Apollo Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. NIBCO INC.
d. Milwaukee Valve Company.
2. Description:
a. Standard: MSS SP-110.
b. Maximum Pressure/Temperature Rating: 100 psig at 300ºF.
c. CWP Rating: 600 psig (4140 kPa).
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded or Solder.
g. Seats: PTFE or TFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel.
j. Port: Regular.

2.03 IRON, LUG STYLE BUTTERFLY VALVES:

A. 200 CWP, Iron, Lug Style Butterfly Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Conbraco Industries, Inc.; Apollo Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-67, Type I.
b. CWP Rating: 200 psig (1380 kPa).

c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
e. Seat: EPDM.
f. Stem: One-piece stainless steel.
g. Disc: 304 Stainless Steel

2.04 SILICON BRONZE SWING CHECK VALVES:

A. Class 125, Silicon Bronze Swing Check Valves with Nonmetallic Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Horizontal flow.
d. Body Material: ASTM B584, bronze.
e. Ends: Threaded.
f. Disc: PTFE or TFE.

2.05 IRON GATE VALVES:

A. Class 125, OS&Y, Iron Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Power Valves.
g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-70, Type I.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Material: ASTM A126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Iron.
f. Disc: Solid wedge.
g. Packing and Gasket: Asbestos free.

2.06 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Class 125, Iron Swing Check Valves with Lever- and Spring-Closure Control:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
   c. Crane Co.; Crane Valve Group; Stockham Division.
   d. Milwaukee Valve Company.
   e. NIBCO INC.
   f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
   a. Standard: MSS SP-71, Type I.
   b. CWP Rating: 200 psig.
   c. Body Design: Clear or full waterway.
   d. Body Material: ASTM A126, gray iron with bolted bonnet.
   e. Ends: Flanged.
   f. Trim: Bronze.
   g. Gasket: Asbestos free.
   h. Closure Control: Factory-installed, exterior lever and spring.

B. Class 125, Iron Swing Check Valves with Lever- and Weight-Closure Control:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
   c. Crane Co.; Crane Valve Group; Stockham Division.
   d. Milwaukee Valve Company.
   e. NIBCO INC.
   f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
   a. Standard: MSS SP-71, Type I.
   b. CWP Rating: 200 psig.
   c. Body Design: Clear or full waterway.
   d. Body Material: ASTM A126, gray iron with bolted bonnet.
   e. Ends: Flanged.
   f. Trim: Bronze.
   g. Gasket: Asbestos free.
   h. Closure Control: Factory-installed, exterior lever and weight.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
B. Operate valves in positions from fully open to fully close. Examine guides and seats made accessible by such operations.
C. Examine threads on valve and mating pipe for form and cleanliness.
D. 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.

E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION:

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
B. Locate valves for easy access and provide separate support where necessary.
C. Install valves in horizontal piping with stem at or above center of pipe.
D. Install valves in position to allow full stem movement.
E. Install chainwheels on operators for valves NPS 4 (DN 100) and larger and more than 96 inches (2400 mm) above floor. Extend chains to 60 inches (1520 mm) above finished floor.
F. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.

3.03 ADJUSTING:

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS:

A. If valve applications are not indicated, use the following:
   1. Shutoff Service: Ball, butterfly, or gate valves.
   2. Butterfly Valve Dead-End Service: Lug type.
   3. Throttling Service: Ball, or butterfly valves.
   4. Pump-Discharge Check Valves:
      a. NPS 2 (DN 50) and Smaller: Bronze swing check valves with nonmetallic disc.
      b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring, metal-seat check valves.
      c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.
B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
C. Select valves, except wafer types, with the following end connections:
   1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
   2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
   3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
   4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
   5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
   6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.

3.05 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE:

A. Pipe NPS 2 (DN 50) and Smaller:
   1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
   2. Ball Valves: Two-piece, regular port, bronze with stainless-steel trim.
   3. Bronze Swing Check Valves: Class 125, nonmetallic disc.
B. Pipe NPS 2-1/2 (DN 65) and Larger:
   1. Iron, Lug Type Butterfly Valves: 200 CWP, EPDM seat, stainless-steel disc.

a. See SECTION 23 09 23 – DIRECT DIGITIAL CONTROL (DDC) SYSTEM FOR HVAC for control valve information.

2. Iron Swing Check Valves with Closure Control: Class 125, lever and spring or weight.

END OF SECTION 22 05 23

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SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

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:
   1. Metal pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.
   4. Thermal-hanger shield inserts.
   5. Fastener systems.
   6. Pipe positioning systems.

1.03 RELATED REQUIREMENTS:

1. DIVISION 05 for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. DIVISION 21, Fire-Suppression Piping Sections for pipe hangers for fire-suppression piping.
3. SECTION 22 05 16 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING for pipe guides and anchors.
4. SECTION 22 05 48 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT for vibration isolation devices.

1.04 REFERENCE STANDARDS:

A. Applicable Standards (Latest Edition):
   1. American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI):
      a. ASCE/SEI 7 - Minimum Design Loads for Buildings and Other Structures.
   2. American Welding Society (AWS):
      a. AWS D1.1/D1.1M - Structural Welding Code - Steel.
   3. ASME International (ASME):
      a. ASME B31.9 - Building Services Piping.
      b. 2007 ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   4. ASTM International (ASTM):
      a. ASTM A36/A36M - Specification for Carbon Structural Steel.
      b. ASTM A780 - Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
      c. ASTM C533 - Specification for Calcium Silicate Block and Pipe Thermal Insulation.
      d. ASTM C552 - Specification for Cellular Glass Thermal Insulation.
      e. ASTM C591 - Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
      f. ASTM C1107 - Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
   5. The International Association of Plumbing and Mechanical Officials (IAPMO):
      a. IAPMO PS 42 - Pipe Alignment and Secondary Support Systems.

6. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):
   a. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture.
   b. MSS SP-69 - Pipe Hangers and Supports - Selection and Application.
   c. MSS SP-89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
7. Metal Framing Manufacturers Association, Inc. (MFMA):
   a. MFMA-4 - Metal Framing Standards Publication.
   b. MFMA-103 - Guidelines for the Use of Metal Framing.
8. The Society for Protective Coatings (SSPC):
   a. SSPC-PA 1 - Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel.

1.05 DEFINITIONS:

A. MSS: Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.

1.06 PERFORMANCE REQUIREMENTS:

A. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
   1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
   2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
   3. Design seismic-restraint hangers and supports for piping and equipment.

1.07 SUBMITTALS:

A. Product Data: For each type of the following:
   1. Steel pipe hangers and supports.
   2. Thermal-hanger shield inserts.
   3. Pipe positioning systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
   1. Trapeze pipe hangers.
   2. Metal framing systems.
   3. Equipment supports.

C. Welding Procedure Specification (WPS) and Welder Performance Qualification Record (WPQR)

1.08 QUALITY ASSURANCE:

A. Structural Steel Welding Qualifications: Qualify welding procedures, welders, and welding operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Weld piping in accordance with qualified procedures using performance qualified welders and welding operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.01 METAL PIPE HANGERS AND SUPPORTS:

A. Carbon-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58 (except as noted in PART 3 - EXECUTION), factory-fabricated components.
   2. Galvanized Metallic Coatings: Pregalvanized 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.

2.02 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.

2.03 METAL FRAMING SYSTEMS:

A. MFMA Manufacturer Metal Framing Systems:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Cooper B-Line, Inc.
      b. Flex-Strut Inc.
      c. Powerstrut Corp.
      d. Unistrut Corporation; Tyco International, Ltd.
   2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
   3. Standard: MFMA-4.
   4. Channels: Continuous slotted steel channel with inturned lips.
   5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
   6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.
   7. Metallic Coating: Electroplated zinc, Hot-dipped galvanized or Mill galvanized.

2.04 THERMAL-HANGER SHIELD INSERTS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Carpenter & Paterson, Inc.
   2. PHS Industries, Inc.
   3. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psig (688-kPa) minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C533, Type I calcium silicate with 100-psig (688-kPa) or ASTM C552 Type II cellular glass with 100-psig (688-kPa) minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
   1. Klo-Shure Insulation Coupling by Hydra-Zorb may be used in lieu of insert and shield.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.05 FASTENER SYSTEMS:

A. 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 PIPE POSITIONING SYSTEMS:

A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.07 MISCELLANEOUS MATERIALS:

A. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5,000-psi (34.5-Mpa), 28-day compressive strength.

PART 3 - EXECUTION

3.01 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. The following figure types given in Figure 1 of MSS SP-69 will not be acceptable: Types 5, 6, 7, 9, 10, 11, 12, 16, 19, 20, 23, 25, 27, 28, 29, and 30. However, Types 7, 9, 10, 10, 11, 19, and 23 may be used for nonferrous and plastic piping systems 2 inches and smaller.

C. 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.

D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

E. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

F. Fastener System Installation:

1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions. Do not use in lightweight concrete or in concrete slabs less than 4 inches thick. Powder actuated fasteners will not be permitted.

G. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. See DIVISION 22 Plumbing Fixture Sections for requirements for pipe positioning systems for plumbing fixtures.
H. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
J. 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.
K. Install lateral bracing with pipe hangers and supports to prevent swaying.
L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (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.
M. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
N. 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.
O. Insulated Piping:
    1. Attach clamps and spacers to piping.
        a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
        b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
        c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
    2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
        a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
    3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
        a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
    4. Shield Dimensions for Pipe: Not less than the following:
        a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
        b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm)] thick.
        c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
        d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
        e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.
    5. Pipes NPS 8 (DN 200) and Larger: Include reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
    6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.02 METAL FABRICATIONS:

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and 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 qualified 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.

3.03 ADJUSTING:

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

3.04 PAINTING:

A. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

3.05 HANGER AND SUPPORT SCHEDULE:

A. Specific hanger and support requirements are in sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

F. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal-hanger shield inserts for insulated piping and tubing.

1. Klo-Shure Insulation Coupling by Hydra-Zorb may be used in lieu of insert and shield for trapeze mounted or clamped piping.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system sections, install the following types:

1. Exception: The following figure types given in Figure 1 of MSS SP-69 will not be acceptable: Types 5, 6, 7, 9, 10, 11, and 12. However, Types 7, 9, 10, and 11 may be used for nonferrous and plastic piping systems 2 inches and smaller.
2. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).

3. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1,050ºF (566ºC), pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4-inches (100-mm) of insulation.
4. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4-inches (100-mm) of insulation.
5. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
6. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
7. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
8. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
9. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
10. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 (DN 65 to DN 900) if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
11. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction might occur.
12. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24 (DN 65 to DN 600), from single rod if horizontal movement caused by expansion and contraction might occur.
13. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 (DN 50 to DN 1050) if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
14. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 (DN 50 to DN 600) if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
15. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 (DN 50 to DN 750) if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system sections, install the following types:
1. Exception: The following figure type given in Figure 1 of MSS SP-69 will not be acceptable: Type 16.
2. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.

3. Steel Clevises (MSS Type 14): For 120 to 450ºF (49 to 232ºC) piping installations.
4. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450ºF (49 to 232ºC) piping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system sections, install the following types:
1. Exception: The following figure types given in Figure 1 of MSS SP-69 will not be acceptable: 19, 20, 23, 25, 27, 28, 29, 30, and 34.
2. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
4. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
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 pounds (340 kg).
   b. Medium (MSS Type 32): 1,500 pounds (680 kg).
   c. Heavy (MSS Type 33): 3,000 pounds (1,360 kg).
6. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
7. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
4. Klo-Shure Insulation Coupling by Hydra-Zorb may be used in lieu of insert and shield for trapeze mounted for clamped installation.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25% to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25% to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25% to allow expansion and contraction of piping system from trapeze support.

8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system sections.

P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system sections.

Q. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

R. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 22 05 29

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SECTION 22 05 53 – IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

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:
   1. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.
   4. Valve tags.
   5. Warning tags.

1.03 REFERENCE STANDARDS:

A. Applicable Standards (Latest Edition):
   1. ASME International (ASME):
      a. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.04 SUBMITTALS:

A. Product Data: For each type of product indicated.
B. Samples: For color, letter style, and graphic representation required for each identification material and device.
C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
D. Valve numbering scheme.
E. Valve Schedules: For each piping system to include in maintenance manuals.

1.05 COORDINATION:

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
B. Coordinate installation of identifying devices with locations of access panels and doors.
C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.01 EQUIPMENT LABELS:

A. Plastic Labels for Equipment:
   1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.
   2. Letter Color: White.
   3. Background Color: Black.
   4. Maximum Temperature: Able to withstand temperatures up to 160ºF (71ºC).
   5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
   6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches

(1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2 by 11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.02 WARNING SIGNS AND LABELS:

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: Yellow.

D. Maximum Temperature: Able to withstand temperatures up to 160ºF (71ºC).

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).

F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.03 PIPE LABELS:

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches (38 mm) high.

2.04 VALVE TAGS:

A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.

1. Tag Material: Brass, 0.032 inch (0.8 mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2 by 11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), 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.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.05 WARNING TAGS:

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
   1. Size: 3 by 5-1/4 inches (75 by 133 mm) minimum.
   2. Fasteners: Reinforced grommet and wire or beaded chain.
   3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
   4. Color: Red background with black lettering.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.02 EQUIPMENT LABEL INSTALLATION:

A. Install or permanently fasten labels on each major item of mechanical equipment.
B. Locate equipment labels where accessible and visible.

3.03 PIPE LABEL INSTALLATION:

A. Piping Color-Coding: Painting of piping is specified in DIVISION 09.
B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible 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 intervals of 50 ft. (15 m) along each run. Reduce intervals to 25 ft. (7.6 m) in areas of congested piping and equipment.
   7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
C. Pipe Label Color Schedule:
   1. Medical Gas and Air System Piping:
      a. Background Color: Yellow.
      b. Letter Color: Black.
   2. Medical Vacuum System Piping:
      a. Background Color: White
      b. Letter Color: Black
   3. WAGD System Piping:
      a. Background Color: Purple

b. Letter Color: White
4. Oxygen Piping:
   a. Background Color: Green.
   b. Letter Color: White.
5. Domestic Water Piping:
   a. Background Color: Blue.
   b. Letter Color: White.
6. Sanitary Waste, Vent, and Storm Drainage Piping:
   a. Background Color: Black.
   b. Letter Color: White.

3.04 VALVE-TAG INSTALLATION:

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
   1. Valve-Tag Size and Shape:
      a. Cold Water: 1-1/2 inches (38 mm), round.
      b. Hot Water: 1-1/2 inches (38 mm), round.
      c. Medical Gas, Air, Vac, WAGD: 1-1/2 inches (38 mm), round.
      d. Oxygen: 1-1/2 inches (38 mm), round.
   2. Valve-Tag Color:
      a. Cold Water: Natural.
      b. Hot Water: Natural.
      c. Medical Gas, Air, Vac, WAGD: Natural.
      d. Oxygen: Green.
   3. Letter Color:
      a. Cold Water: Black.
      b. Hot Water: Black.
      c. Medical Gas, Air, Vac, WAGD: Black.
      d. Oxygen: White.

3.05 WARNING-TAG INSTALLATION:

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 22 05 53

SECTION 22 07 19 – PLUMBING PIPING 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.

1.02 SUMMARY:

A. This SECTION includes requirements for insulating plumbing piping and devices.
   1. Indoor Domestic Hot and Cold Water Piping.
   2. Indoor Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities.
   3. Indoor Floor Drains, Traps, and Sanitary Drain Piping within 10 feet of Drain Receiving Condensate and Equipment Drain Water below 60ºF.
   4. Indoor Hot Service Drains and Vents.

1.03 RELATED REQUIREMENTS:

A. Section 22 07 16 - PLUMBING EQUIPMENT INSULATION.

1.04 REFERENCE STANDARDS:

A. Applicable Standards (latest editions):
   1. ASTM International (ASTM):
      a. ASTM A167 - Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
      b. ASTM A240/A240M - Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
      c. ASTM B209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
      d. ASTM B209M - Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric].
      e. ASTM C534 - Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
      f. ASTM C795 - Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
      g. ASTM C871 - Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate, and Sodium Ions.
      h. ASTM C921 - Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
      i. ASTM C1136 - Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
      j. ASTM C1290 - Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
      k. ASTM D1644 - Test Methods for Nonvolatile Content of Varnishes.
      l. ASTM D1784 - Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
      m. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.
      n. ASTM E96/E96M - Test Methods for Water Vapor Transmission of Materials.

o. ASTM F1249 - Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor.

2. California Department of Health Services:
   a. Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, 2004.
3. Code of Federal Regulations (CFR):
   a. 40 CFR - Protection of Environment, Chapter I - Environmental Protection Agency, Part 59 - "National Volatile Organic Compound Emission Standards for Consumer and Commercial Products," Subpart D - "National Volatile Organic Compound Emission Standards for Architectural Coatings," 2007.
4. Military Specifications:
   a. MIL-A-24179A - Adhesive, Flexible Unicellular-Plastic Thermal Insulation.
   b. MIL-A-3316C - Adhesives, Fire-Resistant, Thermal Insulation.
   c. MIL-PRF-19565C - Coating Compounds, Thermal Insulation, Fire- and Water-Resistant, Vapor Barrier.

1.05 SUBMITTALS:

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).
B. Qualification Data: For qualified Installer.
C. Field quality-control reports.

1.06 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. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
C. Comply with the following applicable standards and other requirements specified for miscellaneous components:
   1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.07 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.

1.08 COORDINATION:

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT.
B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for

installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.09 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 INSULATION MATERIALS:

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials 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. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534, Type I for tubular materials.

1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. Aeroflex USA, Inc.; Aerocel.
   b. Armacell LLC; AP Armaflex.
   c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

2.02 ADHESIVES:

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

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).

B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. Aeroflex USA, Inc.; Aeroseal.
   b. Armacell LLC; Armaflex 520 Adhesive.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
   d. K-Flex USA; R-373 Contact Adhesive.
2. 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).

C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
      b. Eagle Bridges - Marathon Industries; 225.
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-20.
      d. Mon-Eco Industries, Inc.; 22-25.
   2. 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).

D. PVC Jacket Adhesive: Compatible with PVC jacket.
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. Dow Corning Corporation; 739, Dow Silicone.
      b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
      c. P.I.C. Plastics, Inc.; Welding Adhesive.
      d. Speedline Corporation; Polyco VP Adhesive.
   2. 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).

2.03 SEALANTS:

A. Joint Sealants:
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
      b. Eagle Bridges - Marathon Industries; 405.
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
      d. Mon-Eco Industries, Inc.; 44-05.
      e. Pittsburgh Corning Corporation; Pittseal 444.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Permanently flexible, elastomeric sealant.
   4. Service Temperature Range: +100 to +300ºF (+73 to +149ºC).
   5. Color: White.
   6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Fire- and water-resistant, flexible, elastomeric sealant.
   4. Service Temperature Range: +40 to +250ºF (+40 to +121ºC).
   5. Color: White.

6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.04 FACTORY-APPLIED JACKETS:

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, Kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
   2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.

2.05 FIELD-APPLIED JACKETS:

A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.
B. Metal Jacket:
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
      b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
      c. RPR Products, Inc.; Insul-Mate.
   2. Aluminum Jacket: Comply with ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.
      a. Finish and thickness are indicated in field-applied jacket schedules.
      b. Moisture Barrier for Indoor Applications: 3-mil (0.075-mm) thick polysurlyn.
      c. Moisture Barrier for Outdoor Applications: 3-mil (0.075-mm) thick polysurlyn.
      d. Factory-Fabricated Fitting Covers:
         (1) Same material, finish, and thickness as jacket.
         (2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
         (3) Tee covers.
         (4) Flange and union covers.
         (5) End caps.
         (6) Beveled collars.
         (7) Valve covers.
         (8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.06 TAPES:

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. ABI, Ideal Tape Division; 428 AWF ASJ.
      b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
      c. Compac Corporation; 104 and 105.
      d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
   2. Width: 3 inches (75 mm).
   3. Thickness: 11.5 mils (0.29 mm).
   4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.

5. Elongation: 2%.
6. Tensile Strength: 40 lbf./inch (7.2 N/mm) in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Products: Subject to compliance with requirements, provide products by one of the following:
a. ABI, Ideal Tape Division; 370 White PVC tape.
b. Compac Corporation; 130.
c. Venture Tape; 1506 CW NS.
2. Width: 2 inches (50 mm).
3. Thickness: 6 mils (0.15 mm).
4. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
5. Elongation: 500%.
6. Tensile Strength: 18 lbf./inch (3.3 N/mm) in width.

2.07 SECUREMENTS:

A. Bands:
1. Products: Subject to compliance with requirements, provide products by one of the following:
a. ITW Insulation Systems; Gerrard Strapping and Seals.
b. RPR Products, Inc.; Insul-Mate Strapping and Seals.
2. Stainless Steel: ASTM A167 or ASTM A240/A240M, Type 304; 0.015 inch (0.38 mm) thick, 1/2 inch (13 mm) wide.
3. Aluminum: ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005; Temper H 14, 0.020 inch (0.51 mm) thick, 1/2 inch (13 mm) wide.

2.08 PROTECTIVE SHIELDING GUARDS:

A. Protective Shielding Piping Enclosures:
1. Products: Subject to compliance with requirements, provide products by one of the following:
a. Truebro; a brand of IPS Corporation.
b. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.
2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 GENERAL INSTALLATION REQUIREMENTS:

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, 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 1-1/2 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.
        a. For below-ambient services, apply vapor-barrier mastic over staples.
    4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
    5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
M. Cut insulation in a manner to avoid compressing insulation more than 75% 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. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.
Q. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

3.03 PENETRATIONS:

A. 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.

B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
   1. Comply with requirements in DIVISION 07 for firestopping and fire-resistive joint sealers.

D. Insulation Installation at Floor Penetrations:
   1. Pipe: Install insulation continuously through floor penetrations.
   2. Seal penetrations through fire-rated assemblies. Comply with requirements in DIVISION 07.

3.04 GENERAL PIPE INSULATION INSTALLATION:

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete run. Do not use cut pieces or scraps abutting each other.

C. Wood blocking shall not be used.

D. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. 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.
   3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
   4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as 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.

5. 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.
6. Insulate flanges and 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.
7. 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.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, 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.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

E. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. 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.

F. 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.

3.05 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION:

A. Use inserts by the same manufacturer of the insulating system being installed (i.e. for Armaflex, use Armafix.)

B. Seal longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Flanges:
   1. Install 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.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
   4. Secure insulation to flanges and seal seams with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Pipe Fittings and Elbows:
   1. Install mitered sections of pipe insulation.
   2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

E. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed valve covers manufactured of same material as pipe insulation when available.
   2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.
   4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.06 FIELD-APPLIED JACKET INSTALLATION:

A. 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.

3.07 PLUMBING PIPING INSULATION SCHEDULE, GENERAL:

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Drainage piping located in crawl spaces.
   2. Underground piping.
   3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.08 PLUMBING PIPING INSULATION SCHEDULE:

A. Indoor Domestic Hot and Recirculated Water:
   1. NPS 1 inch (25mm) and Smaller Pipe: Insulation shall be:
      a. Flexible Elastomeric: 1 inch (25 mm) thick.

2. NPS 1-1/2 inch (38 mm) and Larger Pipe: Insulation shall be:
    a. Flexible Elastomeric: 1-1/2 inch (38mm) thick.

B. Indoor Domestic Cold Water:
1. All Pipe Sizes: Insulation shall be one of the following:
    a. Flexible Elastomeric: 3/4 inch (19 mm) thick.

C. Stormwater and Overflow Piping, Roof Drain and Overflow Bodies:
1. All Pipe Sizes: From roof drain to vertical stack on level below roof drain. Insulation shall be one of the following:
    a. Flexible Elastomeric: 3/4 inch (19 mm) thick.

D. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
1. All Pipe Sizes:
    a. Preformed Shielding Guard.

E. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet (3 m) of Drain Receiving Condensate and Equipment Drain Water below 60ºF (16ºC):
1. All Pipe Sizes: Insulation shall be one of the following:
    a. Flexible Elastomeric: 3/4 inch (19 mm) thick.

F. Hot Service Drains and Vents:
1. All Pipe Sizes: Insulation shall be the following:
    a. Flexible Elastomeric: 1 inch (25 mm) thick.

3.09 INDOOR, FIELD-APPLIED JACKET SCHEDULE:

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. All insulated piping exposed in mechanical rooms within 7’-0” of finished floor:
1. Aluminum, Embossed: 0.016 inch (0.40 mm) thick.

D. All insulated piping exposed in finished spaces within 7’-0” of finished floor:
1. Aluminum, Smooth: 0.024 inch (0.61 mm) thick.

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SECTION 22 08 00 – PLUMBING COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other DIVISION 1 Specification Sections, apply to this SECTION.

1.02 SUMMARY:

A. This SECTION includes requirements for commissioning the plumbing systems and subsystems and equipment. This SECTION supplements the general requirements specified in SECTION 01 91 13, GENERAL COMMISSIONING REQUIREMENTS.

B. Related Sections include the following:

1. SECTION 01 91 13 – GENERAL COMMISSIONING REQUIREMENTS
2. SECTION 23 08 00 – MECHANICAL COMMISSIONING REQUIREMENTS
3. SECTION 26 08 00 – ELECTRICAL COMMISSIONING REQUIREMENTS

C. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned are specified in SECTION 01 91 13, GENERAL COMMISSIONING REQUIREMENTS and specific related sections. The commissioning process, which the Contractor is responsible to execute, is defined in SECTION 01 91 13, GENERAL COMMISSIONING REQUIREMENTS. A Commissioning Authority (CxA) appointed by the Owner will manage the commissioning process.

D. The following systems and equipment apply to this SECTION:

1. Medical Gas Equipment (i.e. compressors, vacuum pumps)
2. Backflow prevention
3. Shower/faucet/tub temperature control valves
4. Flush valves
5. Eye wash stations
6. Clinical sinks
7. Trap primers
8. Recirc pumps
9. Booster pumps

1.03 DEFINITIONS:

A. BoD: Basis of Design

B. CxA: Commissioning Authority

C. OPR: Owner's Project Requirements

D. Systems, Subsystems, and Equipment: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, and equipment.

1.04 COMMISSIONING TEAM:

A. Members appointed by Construction Manager and Contractor(s): Individuals, each having the authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated action. The commissioning team shall consist of, but not be limited to, representatives of each Contractor, including project superintendent and sub-contractors, installers, suppliers, and specialists deemed appropriate by the CxA.

B. Members Appointed by Owner:

1. CxA: The designated person, company, or entity that plans, schedules, and

coordinates the commissioning team to implement the commissioning process. Owner will engage the CxA under a separate contract.

2. Representatives of the facility user and operation and maintenance personnel.
3. Architect and engineering design professionals.

1.05 CONSTRUCTION MANAGER AND CONTRACTOR'S RESPONSIBILITIES:

A. The following responsibilities are components of the Construction Manager and Contractor scope identified in other related sections. This information is highlighted here for convenience and is not a list of additional services. The only exception to the responsibilities specified elsewhere is that the CxA must be present during these operations in order to comply with the commissioning specification.
   1. Attend with responsible sub-contractors commissioning progress meetings and cooperate with CxA for resolution of issues related to commissioning.
   2. Integrate and coordinate commissioning process activities with construction schedule.
   3. Review and authorize responsible sub-contractors to complete Pre-Functional and Functional Performance Testing (FPT) checklists provided by the CxA.
   4. Authorize sub-contractors to make available technicians and/or coordinate with the manufacturer's authorized technicians to startup plumbing systems, assemblies, and equipment and simulate conditions for the purpose of completing Functional Performance Testing.
   5. Participate with responsible sub-contractors in plumbing systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
   6. Provide equipment operational and maintenance and related information requested by the CxA for final commissioning documentation.

B. Plumbing Subcontractor:
   1. Provide technicians who are familiar with the construction and operation of installed systems to participate in the systems commissioning process.
   2. Provided assistance in developing the test checklists and test procedures.
   3. Provide measuring instruments and logging devices to record test data, and data acquisition equipment to record data for the complete range of testing for the required test period.

C. Electrical Subcontractor:
   1. With the Plumbing Subcontractor, coordinate installations and connections between and among electrical and plumbing systems, subsystems, and equipment.

1.06 COMMISSIONING DOCUMENTATION:

A. Test Checklists: CxA shall develop test checklists for plumbing systems, subsystems, and equipment, including interfaces and interlocks with other systems. In addition to the requirements specified in DIVISION 01 SECTION 01 91 13 "GENERAL COMMISSIONING REQUIREMENTS," checklists shall include, but not be limited to, the following:
   1. Calibration of sensors and sensor function.
   2. Testing conditions under which test was conducted, including (as applicable) ambient conditions, set points, override conditions, and status and operating conditions that impact the results of test.
   3. Control sequences for systems.

4. Responses to control signals at specified conditions.
5. Sequence of response(s) to control signals at specified conditions.
6. Narrative description of observed performance of systems, subsystems, and equipment. Notation to indicate whether the observed performance at each step meets the expected results.
7. Interaction of auxiliary equipment.
8. Commissioning Issues Log.

B. Contractors shall provide the following information to the CxA for inclusion in the Commissioning Process Final Report:
1. Copy of contractor's 'as-built' drawings indicating changes that occurred during the construction phase. The original as-built drawings are processed in accordance with requirements specified elsewhere.
2. Copies of plan and documentation requirements for start-up and initial checkout.
3. Copies of completed pre-functional and functional performance testing checklists.
4. Copies of Commissioning Issues Log with contractor's confirmation of resolution or recommendation for resolution.

1.07 SUBMITTALS:

A. Certificate of Readiness: CxA will compile certificates of readiness from the Contractor certifying that systems, subsystems, equipment, and associated controls are ready for testing.
1. Certified Pipe Cleaning and Flushing Report: CxA will collect test reports certifying that pipe cleaning; flushing, hydrostatic testing, and chemical treating have been completed.
2. Test and Inspection Reports: CxA will compile and submit test reports and certificates, and shall include them in the commissioning report.
3. Corrective Action Documents: CxA will maintain and submit corrective action documents.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - PART 3 - EXECUTION

3.01 PRE-FUNCTIONAL CHECKLISTS:

A. The Commissioning Authority will prepare Pre-Functional Checklists to be used to document equipment installation. The Contractor shall complete Pre-Functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing. Completed checklists shall be submitted to the Commissioning Authority for review. The CxA will spot check a sample of completed checklists. If the information provided on the checklist is found to be inaccurate, the checklist will be rejected and returned to the Contractor for correction and resubmission. If the CxA determines that a significant number of the broader sample of checklists is also inaccurate, all checklists for that type of equipment will be returned to the Contractor for correction and resubmission.

3.02 CONTRACTOR TESTS:

A. Contractor tests as required by other sections of DIVISION 22 shall be scheduled and documented in accordance with DIVISION 01 – General Requirements. The

Commissioning Authority will witness selected Contractor tests. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

3.03 SYSTEMS FUNCTIONAL PERFORMANCE TESTING

A. The Commissioning Process includes Functional Performance Testing intended to test system functional performance under steady state conditions, system reaction to changes in operating conditions, and system performance under emergency conditions. The Contractor shall provide the required labor, materials, and test equipment identified in the test procedure to perform the tests. The Commissioning Authority will witness and document the testing. See SECTION 01 91 13 - GENERAL COMMISSIONING REQUIREMENTS, for additional details.

END OF SECTION 22 08 00

SECTION 22 11 16 – 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.

1.02 SUMMARY:

A. This SECTION includes:
   1. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings, including combined water piping serving domestic and fire suppression systems.

1.03 RELATED REQUIREMENTS:

A. Specification 07 84 13 – Penetration Firestopping.
B. Division 21 - For water-service piping serving only fire suppression systems.
C. Division 33 - For water-service piping and water meters outside the building from source to the point where water-service piping enters the building.

1.04 REFERENCED STANDARDS:

A. Applicable Standards (Latest Edition):
   1. American Society of Sanitary Engineering (ASSE):
      a. ASSE 1079 - Dielectric Pipe Unions.
   2. American Water Works Association (AWWA):
      a. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
      b. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems (ANSI).
      c. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings for Water (ANSI).
      d. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings (ANSI).
      e. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids (ANSI).
      f. AWWA C153/A21.53 - Ductile-Iron Compact Fittings for Water Service (ANSI).
      g. AWWA C219 - Bolted, Sleeve-Type Couplings for Plain-End Pipe.
      h. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
      i. AWWA C606 - Grooved and Shouldered Joints.
      j. AWWA C651 - Disinfecting Water Mains.
      k. AWWA C652 - Disinfection of Water-Storage Facilities.
      l. AWWA M41 - Ductile-Iron Pipe and Fittings.
   3. American Welding Society (AWS):
      a. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding.
   4. ASME International (ASME):
      a. ASME B1.20.1 - Pipe Threads, General Purpose, Inch.
      b. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
      c. ASME B16.4 - Gray Iron Threaded Fittings: Classes 125 and 250.
      d. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.
      e. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

f. ASME B16.24 - Cast Copper Alloy Pipe Flanges and Flanged Fittings: Classes 150, 300, 600, 900, 1500, and 2500.
g. ASME B16.39 - Malleable Iron Threaded Pipe Unions: Classes 150, 250, and 300.
h. ASME B18.2.1 - Square and Hex Bolts and Screws, Inch Series.
i. ASME B31.9 - Building Services Piping.

5. ASTM International (ASTM):
   a. ASTM A53/A53M - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   b. ASTM A106/A106M - Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
   c. ASTM A536 - Specification for Ductile Iron Castings.
   d. ASTM A674 - Practice for Polyethylene Encasement for Ductile Iron Pipe for Water or Other Liquids.
   e. ASTM A733 - Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples.
   f. ASTM B32 - Specification for Solder Metal.
   g. ASTM B88 - Specification for Seamless Copper Water Tube.
   h. ASTM B88M - Specification for Seamless Copper Water Tube [Metric].
   i. ASTM B813 - Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube.
   j. ASTM B828 - Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.
   k. ASTM F876 – Specifications for Cross-Linked Polyethylene (PEX) tubing.
   l. ASTM F877 – Specification for Cross-Linked Polyethylene (PEX) plastic hot and cold water distributions systems.
6. California Department of Health Services:
   a. Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, 2004.
7. Code of Federal Regulations (CFR):
   a. 40 CFR 141, Subpart E – Special Regulations, Including Monitoring Regulations and Prohibition on Lead Use.
8. Copper Development Association:
   a. Copper Tube Handbook, 2006.
9. International Association of Plumbing and Mechanical Officials (IAPMO):
   a. IAPMO PS 66 - Dielectric Waterway Fittings.
10. International Plumbing Code (IPC) – 2018.
11. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):
   a. MSS SP-69 - Pipe Hangers and Supports - Selection and Application (ANSI).
   b. MSS SP-123 - Non-Ferrous Threaded and Solder-Joint Unions for Use with Copper Water Tube.
12. NSF International (NSF):
   a. NSF 14 - Plastics Piping System Components and Related Materials
   b. NSF 61 - Drinking Water System Components - Health Effects
   c. NSF 372 - Drinking Water System Components - Lead Content.

1.05 SUBMITTALS:

A. Product Data: For piping, transition fittings, and dielectric fittings. Submit schedule of pipe materials used for each application.
B. System purging and disinfecting activities report.
C. Field quality-control reports.

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, NSF 61, and NSF 372. Plastic piping components shall be marked with "NSF-pw."
C. Potable-water piping and components shall comply with 40 CFR 141, Subpart E including all amendments in place at the time of bids.

2.02 COPPER TUBE AND FITTINGS:

A. Hard Copper Tube: ASTM B88, ASTM B88, Type L (ASTM B88M, Type B) water tube, drawn temper.
B. Soft Copper Tube: ASTM B88, Type K (ASTM B88M, Type A) water tube, annealed temper.
C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
E. 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.

2.03 PEX-A PIPING AND FITTINGS:

A. Piping 1/4-inch through 1-inch nominal size:
    1. SDR9 crosslinked polyethylene manufactured using the Engel method (PEX-A)
        a. Minimum degree of cross-linking shall be between 70-89% when tested in accordance with ASTM D2765, Method B.
    2. Manufacturer in accordance with ASTM F876 and ASTM F877 and tested for compliance by and independent, third-party agency.
        a. Piping to have a minimum material designation of PEX 5106.
    3. Temperature and pressure requirements in accordance with PPI TR-3; 73.4°F at 80psi, 180°F at 100psi and 200°F at 80psi.
B. Manufactured Joint: 3/8-inch through 1-inch nominal pipe size:
    1. ASTM F1960 cold-expansion fitting manufactured from the following material types:
        a. UNS No. C69300 Lead-Free (LF) Brass.

2.04 GALVANIZED-STEEL PIPE AND FITTINGS:

A. Galvanized-Steel Pipe:
    1. ASTM A53/A53M, Type E, standard weight.
    2. Include ends matching joining method.
B. Galvanized-Steel Pipe Nipples: ASTM A733, made of ASTM A53/A53M or ASTM A106/A106M, Standard Weight, seamless steel pipe with threaded ends.

C. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
D. Malleable-Iron Unions:
   1. ASME B16.39, Class 150.
   2. Hexagonal-stock body.
   3. Ball-and-socket, metal-to-metal, bronze seating surface.
   4. Threaded ends.
E. Flanges: ASME B16.1, Class 125, cast iron.
F. Appurtenances for Grooved-End, Galvanized-Steel Pipe:
   1. Manufacturers: Subject to compliance with requirements provide products by one of the following:
      a. Anvil International.
      b. Grinnell Mechanical Products; Tyco Fire Products LP.
      c. Victaulic Company.
   2. Fittings for Grooved-End, Galvanized-Steel Pipe: Galvanized, ASTM A47/A47M, malleable-iron casting; ASTM A106/A106M, steel pipe; or ASTM A536, ductile-iron casting; with dimensions matching steel pipe.
   3. Fittings for Grooved-End, Galvanized-Steel Pipe:
      a. AWWA C606 for steel-pipe dimensions.
      b. Ferrous housing sections.
      c. EPDM-rubber gaskets suitable for hot and cold water.
      d. Bolts and nuts.
      e. Minimum Pressure Rating:
         (1) NPS 8 (DN 200) and Smaller: 600 psig (4137 kPa).
         (2) NPS 10 and NPS 12 (DN 250 to DN 300): 400 psig (2758 kPa).
         (3) NPS 14 to NPS 24 (DN 350 to DN 600): 250 psig (1725 kPa).

2.05 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 B32, lead-free alloys.
D. Flux: ASTM B813, water flushable.
E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated.

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 C219.3.
   1. Manufacturers: Subject to compliance with requirements provide products by one of the following:

a. Dresser, Inc.; Piping Specialties Products.
b. JCM Industries.
c. Smith, Jay R. Mfg. Co.
d. Smith-Blair, Inc.; a Sensus company.
e. Viking Johnson.

2.07 DIELECTRIC FITTINGS:

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Flanges:
1. Manufacturers: Subject to compliance with requirements provide products by one of the following:
a. Capitol Manufacturing Company.
b. Watts; a division of Watts Water Technologies, Inc.
c. Wilkins; a Zurn company.
d. Zurn Industries, LLC.
2. Standard: ASSE 1079.
3. Factory-fabricated, bolted, companion-flange assembly.
4. Pressure Rating: 150 psig (1035 kPa), minimum at 180ºF. Pressure rating shall be minimum 20 psi above system design pressure.
5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

C. Dielectric-Flange Insulating Kits:
1. Manufacturers: Subject to compliance with requirements provide products by one of the following:
a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Central Plastics Company.
d. Pipeline Seal and Insulator, Inc.
2. Non-conducting materials for field assembly of companion flanges.
3. Pressure Rating: 150 psig (1035 kPa) or 25 psi above system design pressure, whichever is higher.
4. Gasket: Neoprene or phenolic.
5. Bolt Sleeves: Phenolic or polyethylene.
6. Washers: Phenolic with steel backing washers.

D. Dielectric Nipples and Waterways:
1. Manufacturers: Subject to compliance with requirements provide products by one of the following:
a. Elster Perfection Corporation.
b. Grinnell Mechanical Products; Tyco Fire Products LP.
c. Matco-Norca.
d. Precision Plumbing Products, Inc.
e. Victaulic Company.
2. Standard: IAPMO PS 66.
3. Electroplated steel nipple complying with ASTM F1545.
4. Pressure Rating and Temperature: 300 psig (2070 kPa) at 225ºF (107ºC).

5. End Connections: Male threaded, flanged, or grooved.
6. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.01 GENERAL:

A. All work shall be installed and tested in compliance with International Plumbing Code (IPC) – 2018.

3.02 EARTHWORK:

A. Comply with requirements in DIVISION 31 for excavating, trenching, and backfilling.

3.03 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 ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
D. Install shutoff valve, hose-end drain valve, strainer, pressure gauge, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gauges in SECTION 22 05 19 - METERS AND GAGES FOR PLUMBING PIPING and with requirements for drain valves and strainers in SECTION 22 11 19 - DOMESTIC WATER PIPING SPECIALTIES.
E. Install shutoff valve immediately upstream of each dielectric fitting.
F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in SECTION 22 11 19 - DOMESTIC WATER PIPING SPECIALTIES.
G. Install domestic and non-potable water piping level with 0.25% slope downward toward drain, unless otherwise indicated, and plumb.
H. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices in SECTION 22 05 48 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT.
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 PEX piping with loop at each change of direction of more than 90 degrees.

Q. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
R. Do not install grooved-joint over ceilings or over finished space.
S. Install pressure gauges on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gauges in SECTION 22 05 19 - METERS AND GAGES FOR PLUMBING PIPING.
T. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in SECTION 22 11 23.21 - DOMESTIC WATER PUMPS.
U. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in SECTION 22 05 19 - METERS AND GAGES FOR PLUMBING PIPING.
V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in SECTION 22 05 17 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING.
W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in SECTION 22 05 17 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING.
X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in SECTION 22 05 18 - ESCUTCHEONS FOR PLUMBING PIPING.
Y. Install firestopping systems for piping penetration of rated walls, ceiling, and floor. Comply with requirements for firestopping specified in SECTION 07 84 13 – PENETRATION FIRESTOPPING.

3.04 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," "Brazed Joints" chapter.
E. Soldered Joints for Copper Tubing: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B828 or CDA's "Copper Tube Handbook."
F. Joint Construction for Grooved-End Steel Piping: Make joints according to AWWA C606. Square cut or roll groove ends of pipe per coupling manufacturer’s written requirements. 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.
G. 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.
H. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.05 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.
C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 (DN 50) and Smaller: Plastic-to-metal transition fittings or unions.

3.06 DIELECTRIC FITTING INSTALLATION:

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric waterways.
C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges or flange kits.
D. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.07 HANGER AND SUPPORT INSTALLATION:

A. Comply with requirements for seismic-restraint devices in SECTION 22 05 48 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT.
B. Comply with requirements for pipe hanger, support products, and installation in SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT.
   1. Vertical Piping: MSS Type 8 or 42, clamps.
   2. Individual, Straight, Horizontal Piping Runs:
      a. MSS Type 1, adjustable, steel clevis hangers.
   3. Base of Vertical Piping: MSS Type 52, spring hangers.
C. Support vertical piping and tubing at base and at each floor.
D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch (10 mm).
E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 3/4 (DN 20) and Smaller: 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
   2. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
   3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
   4. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
   5. NPS 3 to NPS 4 (DN 80 to DN 10): 10 feet (3 m) with 1/2-inch (13-mm) rod.
F. Install supports for vertical copper tubing every 10 feet (3 m).
G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4 (DN 32) and Smaller: 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
   2. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
   3. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
   4. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
   5. NPS 3 and NPS 3-1/2 (DN 80 and DN 90): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
   6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.
   7. NPS 6 (DN 150): 12 feet (3.7 m) with 3/4-inch (19-mm) rod.
   8. NPS 8 to NPS 12 (DN 200 to DN 300): 12 feet (3.7 m) with 7/8-inch (22-mm) rod.

H. Install supports for vertical steel piping every 15 feet (4.5 m).
I. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.08 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. Comply with requirements for connection sizes in DIVISION 22 PLUMBING FIXTURE SECTIONS.
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.

3.09 IDENTIFICATION:
A. Identify system components. Comply with requirements for identification materials and installation in SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT.
B. Label pressure piping with system operating pressure.

3.10 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 and non-potable 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 and non-potable 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 and non-potable water piping will be considered defective if it does not pass tests and inspections.
C. Prepare test and inspection reports.

3.11 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.

3.12 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.

3.13 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. Under-building-slab, trap primer and NPCW-service piping, NPS 1 (DN 25) and smaller, shall be one of the following:

1. Soft copper tube, ASTM B88, Type K (ASTM B88M, Type A); wrought-copper, solder-joint fittings; and brazed joints.

2. PEX-A, ASTM F876 and ASTM F877, with Expansion Fittings. Piping shall be continuous from slab penetration to termination point without fittings.

D. Aboveground domestic water piping, NPS 2 (DN 50) and smaller, shall be one of the following:

1. Hard copper tube, ASTM B88, Type L (ASTM B88M, Type B); cast- or wrought-copper, solder-joint fittings; and brazed or soldered joints.

E. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be one of the following:

1. Hard copper tube, ASTM B88, Type L (ASTM B88M, Type B); cast- or wrought-copper, solder-joint fittings; and brazed or soldered joints.

F. Aboveground domestic water piping (including combined fire service, if applicable), NPS 5 (DN 125) and larger, shall be one of the following:

1. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.

2. Hard copper tube, ASTM B88, Type L (ASTM B88M, Type B); cast- or wrought-copper, solder-joint fittings; and brazed or soldered joints.

3.14 VALVE SCHEDULE:

A. All valves serving potable water systems shall meet the requirements of NSF 61.

B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Shutoff Duty: Use ball or gate valves for piping NPS 2 (DN 50) and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
   2. Throttling Duty: Use ball or globe 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: See SECTION 22 11 19 – DOMESTIC WATER PIPING SPECIALTIES.
   4. Drain Duty: Hose-end drain valves.
C. Use check valves to maintain correct direction of domestic water flow to and from equipment.
D. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION 22 11 16

SECTION 22 11 19 – 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.

1.02 SUMMARY:

A. This SECTION includes:
   1. Backflow preventers.
   2. Water pressure-reducing valves.
   3. Balancing valves.
   4. Temperature-actuated, water mixing valves.
   5. Strainers.
   6. Outlet boxes.
   7. Drain valves.
   8. Water-hammer arresters.
   9. Trap-seal primer systems.
   10. Specialty valves.
   11. Flexible connectors.

1.03 RELATED REQUIREMENTS:

A. SECTION 22 05 19 - METERS AND GAUGES FOR PLUMBING PIPING for thermometers, pressure gauges, and flow meters in domestic water piping.
B. SECTION 22 11 16 - DOMESTIC WATER PIPING.
C. SECTION 22 43 00 - HEALTHCARE PLUMBING FIXTURES for thermostatic mixing valves for sitz baths, thermostatic mixing-valve assemblies for hydrotherapy equipment, and outlet boxes for dialysis equipment.
D. SECTION 22 45 00 - EMERGENCY PLUMBING FIXTURES for water tempering equipment.
E. SECTION 22 47 16 - PRESSURE WATER COOLERS for water filters for water coolers.
F. SECTION 22 32 00 - DOMESTIC WATER FILTRATION EQUIPMENT for water filters in domestic water piping.

1.04 REFERENCE STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
B. American Society of Sanitary Engineering (ASSE):
   1. ASSE 1001 - Performance Requirements for Atmospheric Type Vacuum Breakers.
   2. ASSE 1003 - Performance Requirements for Water Pressure-Reducing Valves (ANSI).
   3. ASSE 1010 - Performance Requirements for Water-Hammer Arresters (ANSI).
   4. ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers (ANSI).
   5. ASSE 1013 - Performance Requirements for Reduced-Pressure-Principle Backflow Preventers and Reduced-Pressure Fire-Protection Principle Backflow Preventers (ANSI).
   6. ASSE 1015 - Performance Requirements for Double-Check Backflow-Prevention Assemblies and Double-Check Fire-Protection Backflow Prevention Assemblies (ANSI).
   7. ASSE 1016 - Performance Requirements for Automatic Compensating Valves for Individual Showers and Tub/Shower Combinations (ANSI).

8. ASSE 1017 - Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems.
9. ASSE 1018 - Performance Requirements for Trap-Seal Primer Valves - Potable Water Supplied (ANSI).
10. ASSE 1019 - Performance Requirements for Vacuum Breaker Wall Hydrants, Freeze Resistant, Automatic Draining Type (ANSI).
11. ASSE 1020 - Performance Requirements for Pressure Vacuum Breaker Assembly (ANSI).
12. ASSE 1022 - Performance Requirements for Backflow Preventer for Beverage Dispensing Equipment (ANSI).
13. ASSE 1024 - Performance Requirements for Dual-Check Backflow Preventers (ANSI).
14. ASSE 1032 - Performance Requirements for Dual-Check Valve Type Backflow Preventers for Carbonated Beverage Dispensers - Post Mix Type.
15. ASSE 1035 - Performance Requirements for Laboratory Faucet Backflow Preventers.
16. ASSE 1044 - Performance Requirements for Trap-Seal Primer Devices - Drainage Types and Electronic Design Types (ANSI).
17. ASSE 1047 - Performance Requirements for Reduced-Pressure Detector Fire-Protection Backflow-Prevention Assemblies (ANSI).
18. ASSE 1048 - Performance Requirements for Double-Check Detector Fire-Protection Backflow-Prevention Assemblies (ANSI).
19. ASSE 1052 - Performance Requirements for Hose Connection Backflow Preventers (ANSI).
20. ASSE 1056 - Performance Requirements for Spill-Resistant Vacuum Breaker (ANSI).
21. ASSE 1057 - Performance Requirements for Freeze-Resistant Sanitary Yard Hydrant with Backflow Protection.

C. American Water Works Association (AWWA):
1. AWWA C550 - Protective Epoxy Interior Coatings for Valves and Hydrants.
2. AWWA C700 - Cold-Water Meters Displacement Type, Bronze Main Case.
3. AWWA C701 - Cold-Water Meters Turbine Type, for Customer Service.
4. AWWA C702 - Cold-Water Meters Compound Type.
5. AWWA C706 - Direct Reading, Remote Registration Systems for Cold-Water Meters.
6. AWWA C707 - Encoder Type Remote Registration Systems for Cold-Water Meters.
7. AWWA C710 - Cold-Water Meters - Displacement Type, Plastic Main Case.

D. ASME International (ASME):
1. ASME A112.1.2 - Air Gaps in Plumbing Systems (for Plumbing Fixtures and Water-Connected Receptors).
2. ASME A112.18.1 - Plumbing Supply Fittings.
3. ASME A112.21.3M - Hydrants for Utility and Maintenance Use.
4. ASME B1.20.7 - Hose Coupling Screw Threads, Inch.

E. ASTM International (ASTM):
1. ASTM B62 - Specification for Composition Bronze or Ounce Metal Castings.
2. ASTM B88 - Specification for Seamless Copper Water Tube.
3. ASTM B88M - Specification for Seamless Copper Water Tube [Metric].

F. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):
1. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves.
2. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

G. NFPA:
   1. NFPA 70 - National Electrical Code.
H. NSF International (NSF):
   1. NSF 61 - Drinking Water System Components - Health Effects; Sections 1 through 9 (ANSI).
   2. NSF 372 – Drinking Water System Components – Lead Content
I. Plumbing & Drainage Institute (PDI):
   1. PDI-WH 201 - Water-Hammer Arresters.

1.05 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.
C. Field quality-control reports.
D. 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 and 372.

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 (BFP-#):
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ames Fire & Waterworks; a division of Watts Regulator Co.
      b. Conbraco Industries, Inc.
      c. FEBCO; SPX Valves & Controls.
      d. Flomatic Corporation.
      e. Watts Water Technologies, Inc.
      f. Wilkins; a Zurn company.
   2. Body:
      a. NPS 2 (DN 50) and Smaller: Bronze.
      b. NPS 2-1/2 (DN 65) and Larger: Cast iron, steel or stainless steel.
      c. Cast iron and steel body backflow preventers shall be provided with interior lining complying with AWWA C550 or that is FDA approved.
   3. Standards: ASSE 1013 or AWWA C511.
   4. Operation: Continuous-pressure applications.
   5. Pressure Loss: 12 psig (83 kPa) maximum, through middle 1/3 of flow range.
   6. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
   7. Accessories:

a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 (DN 50) and smaller; OS&Y gate type with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.
b. Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.

8. Capacities and Characteristics: See Drawings.

B. Double-Check, Backflow-Prevention Assemblies (BFP-FP):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Ames Fire & Waterworks; a division of Watts Regulator Co.
b. Conbraco Industries, Inc.
c. FEBCO; SPX Valves & Controls.
d. Flomatic Corporation.
e. Watts Water Technologies, Inc.
f. Wilkins; a Zurn company.
2. Standard: ASSE 1015 or AWWA C510.
3. Operation: Continuous-pressure applications, unless otherwise indicated.
4. Pressure Loss: 5 psig (35 kPa) maximum, through middle 1/3 of flow range.
5. Body:
a. NPS 2 (DN 50) and Smaller: Bronze.
b. NPS 2-1/2 (DN 65) and Larger: Cast iron, steel or stainless steel.
c. Cast iron and steel body backflow preventers shall be provided with interior lining complying with AWWA C550 or that is FDA approved.
6. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
7. Accessories: Ball valves with threaded ends on inlet and outlet of NPS 2 (DN 50) and smaller; OS&Y gate valves with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.
8. Capacities and Characteristics: See Drawings.

C. Dual-Check-Valve Backflow Preventers (BFP-10):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Conbraco Industries, Inc.
b. FEBCO; a division of Watts Water Technologies, Inc.
c. Flomatic Corporation.
d. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
e. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
2. Standard: ASSE 1024.
3. Operation: Continuous-pressure applications.
4. Size: See Drawings.
5. Body: Bronze with union inlet.

D. Hose-Connection Backflow Preventers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Conbraco Industries, Inc.
b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
c. Woodford Manufacturing Company; a division of WCM Industries, Inc.
2. Standard: ASSE 1052.

3. Operation: Up to 10-foot head of water (30-kPa) back pressure.
4. Inlet Size: NPS 1/2 or NPS 3/4 (DN 15 or DN 20).
5. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
6. Capacity: At least 3-gpm (0.19-L/s) flow.

E. Backflow Preventer Test Kits:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc.
   b. FEBCO; SPX Valves & Controls.
   c. Flomatic Corporation.
   d. Watts Water Technologies, Inc.
   e. Wilkins; a Zurn company.
2. Description: Factory calibrated, with gauges, fittings, hoses, and carrying case with test-procedure instructions.

2.04 WATER PRESSURE-REDUCING VALVES:

A. Water Regulators (DPRV-#):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Cash Acme; a division of Reliance Worldwide Corporation.
   b. Conbraco Industries, Inc.
   c. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   d. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig (1035 kPa).
4. Body: Bronze with chrome-plated finish for NPS 2 (DN 50) and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).
5. End Connections: Threaded for NPS 2 (DN 50) and smaller, flanged for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).
6. Capacities and Characteristics: See Drawings.

2.05 BALANCING VALVES:

A. Copper-Alloy Calibrated Balancing Valves (PCS-#):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong International, Inc.
   b. ITT Corporation; Bell & Gossett Div.
   c. NIBCO, Inc.
   d. TACO, Incorporated.
   e. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
2. Type: Ball or Y-pattern globe valve with two readout ports and memory-setting indicator.
3. Body: Lead Free, Brass or bronze.
4. Size: Same as connected piping, but not larger than NPS 2 (DN 50).
5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

2.06 ELECTRONIC, WATER MIXING VALVES (MV-01A & MV-01B):

A. Primary, Programmable, Electronic Water Tempering Valves:
   1. Manufacturers: Provide products by following without substitution:
      a. Armstrong International, Inc, The Brain Model DRV80.
   2. Standard: ASSE 1017, electronically controlled, water tempering valve.
   3. Pressure Rating: 200 psig (1380 kPa) minimum, unless otherwise indicated.
   4. Body: Lead-free brass 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: 130ºF.
   9. Disinfection temperature range: 100°F to 185°F.
   10. Minimum System Draw Off: 0 gpm.
   11. Controller approvals: CD, FCC Part 15.
   12. Electrical: 100-240V AC with polymer electronics enclosure.
   13. Controls: Integral, programmable.
   14. Tempered-Water Design Flow Rate: Per schedule.

2.07 TEMPERATURE-ACTUATED, WATER MIXING VALVES (TMV-#):

A. Individual-Fixture, Water Tempering Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Cash Acme; a division of Reliance Worldwide Corporation.
      b. Conbraco Industries, Inc.
      c. Honeywell International, Inc.
      d. Lawler Manufacturing Company, Inc.
      e. Leonard Valve Company.
      f. Powers; a division of Watts Water Technologies, Inc.
      g. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
      h. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
   2. Standard: ASSE 1016, 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 with locknut.
   6. Inlets and Outlet: Threaded with check valves with SS screen.
   7. Finish: Rough or chrome-plated bronze.
   8. Tempered-Water Setting: 110ºF.
   9. Tempered-Water Design Flow Rate: Per fixture schedule.

2.08 MECHANICAL, WATER MIXING VALVES:

A. Individual-Fixture, Water Tempering Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Chicago Faucets.
      b. Symmons.
      c. Koehler.
      d. Sloan.

e. American Standard.
2. Body: Brass, NSF 61/372 compliant.
3. Temperature Control: Adjustable with lock screw.
4. Inlets and Outlet: Threaded with check valves.
5. Finish: Rough or chrome-plated bronze.
6. Tempered-Water Setting: 110ºF.
7. Tempered-Water Design Flow Rate: Per fixture schedule.

2.09 STRAINERS FOR DOMESTIC WATER PIPING:

A. Y-Pattern Strainers:
1. Pressure Rating: 125 psig (860 kPa) minimum, unless otherwise indicated.
2. Body:
a. NPS 2 (DN 50) and Smaller: Bronze.
b. NPS 2-1/2 (DN 65) and Larger: Cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated.
3. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:
a. Strainers NPS 2 (DN 50) and Smaller: 0.033 inches (0.84 mm).
b. Strainers NPS 2-1/2 to NPS 4 (DN 65 to DN 100): 0.045 inches (1.14 mm).
c. Strainers NPS 5 (DN 125) and Larger: 0.125 inches (3.18 mm).
6. Drain: Pipe plug or factory-installed, hose-end drain valve as indicated.

2.10 DRAIN VALVES:

A. Ball-Valve-Type, Hose-End Drain Valves:
1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig (2760-kPa) minimum CWP.
3. Size: NPS 3/4 (DN 20).
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.11 WATER-HAMMER ARRESTERS:

A. Water-Hammer Arresters:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. AMTROL, Inc.
b. Josam Company.
c. Precision Plumbing Products, Inc.
d. Sioux Chief Manufacturing Company, Inc.
e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
f. Watts Drainage Products.

g. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Metal bellows.
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.12 TRAP-SEAL PRIMER SYSTEMS (TP-#):

A. Trap-Seal Primer Systems:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Precision Plumbing Products, Inc.
b. Engineer-approved equal.
2. Standard: ASSE 1044.
3. Piping: NPS 3/4, ASTM B88, Type L (DN 20, ASTM B88M, Type B); copper, water tubing.
4. Cabinet: Surface-mounted steel box with stainless-steel cover.
5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120Vac power.
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.
6. Vacuum Breaker: ASSE 1001.
7. Number Outlets: See Drawings.
8. Size Outlets: NPS 1/2 (DN 15).

2.13 SPECIALTY VALVES:

A. Comply with requirements for general-duty metal valves in DIVISION 22, SECTION "GENERAL-DUTY VALVES FOR PLUMBING PIPING."

2.14 FLEXIBLE CONNECTORS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Hyspan Precision Products, Inc.
2. Metraflex, Inc.
3. Engineer-approved equal.
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 250 psig (1725 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 water regulators with inlet and outlet shutoff valves. Install pressure gauges on inlet and outlet.

C. Install balancing valves in locations where they can easily be adjusted.

D. 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.

E. Install Y-pattern strainers for water on supply side of each backflow preventor, water pressure-reducing valve, solenoid valve, and pump.

F. Install outlet boxes recessed in wall. Install 2- by 4-inch (38- by 89-mm) fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in DIVISION 06.

G. Install hose reels on wall where indicated. Provide with dedicated hose bibb for isolation of hose reel.

H. Install ground hydrants with 1 cu. yd. (0.75 cu. m) of crushed gravel around drain hole. Set ground hydrants with box flush with grade.

I. Install water-hammer arresters in water piping according to PDI-WH 201.

J. Install manual air vents at high points of water piping. Install drain piping and discharge onto floor drain in equipment and mechanical rooms.

K. Installation of water meter, valving, bypass loop and water sampler/test outlet shall be in strict accordance with manufacturer's printed instructions and recommendations, applicable ANSI and AWWA requirements, and as detailed on drawings.

L. Water meters shall be installed with a three-way bypass design using ball valves (2" or less) or OS&Y rising stem gate valves (larger than 2"). The bypass valve shall be full-flow and capable of being locked. All other valves associated with the meter installation shall be ball valves.

M. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1%, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.02 CONNECTIONS:

A. Comply with requirements for piping specified in other DIVISION 22 SECTIONS. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements for ground equipment in DIVISION 26.

C. Fire-retardant-treated-wood blocking is specified in DIVISION 26 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. Pressure vacuum breakers.
2. Spill-resistant vacuum breaker backflow preventers.
3. Reduced-pressure-principle backflow preventers.
4. Double-check, backflow-prevention assemblies.
5. Dual-check-valve backflow preventers.
6. Water pressure-reducing valves.
7. Calibrated balancing valves.
8. Primary, thermostatic, water mixing valves.

9. Outlet boxes.
10. Hose reels.
11. Trap-seal primer systems.

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 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT.

3.04 FIELD QUALITY CONTROL:

A. Perform the following tests and inspections:
1. Test each pressure vacuum breaker and 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 and manual, water mixing valves.

END OF SECTION 22 11 19

SECTION 22 13 16 – 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.

1.02 SUMMARY

A. This SECTION includes:
   1. Pipe, tube, and fittings.
   2. Specialty pipe fittings.

B. Related Sections:
   1. SECTION 22 13 29 - SANITARY SEWERAGE PUMPS for effluent and sewage pumps.

1.03 REFERENCES

A. Applicable Standards (Latest Edition):
   1. American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI):
      a. ASCE/SEI 7 - Minimum Design Loads for Buildings and Other Structures.
   2. ASME International (ASME):
      a. ASME B1.20.1 - Pipe Threads, General Purpose, Inch.
      b. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings - Classes 25, 125, and 250.
      c. ASME B16.4 - Gray Iron Threaded Fittings - (Classes 125 and 250).
      d. ASME B16.12 - Cast Iron Threaded Drainage Fittings.
      e. ASME B16.39 - Malleable Iron Threaded Pipe Unions.
      f. ASME B18.2.1 - Square and Hex Bolts and Screws, Inch Series.
   3. ASTM International (ASTM):
      a. ASTM A47/A47M - Specification for Ferritic Malleable Iron Castings.
      b. ASTM A48/A48M - Specification for Gray Iron Castings.
      c. ASTM A53/A53M - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      d. ASTM A74 - Specification for Cast Iron Soil Pipe and Fittings.
      e. ASTM A536 - Specification for Ductile Iron Castings.
      f. ASTM A733 - Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples.
      g. ASTM A888 - Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
      h. ASTM C564 - Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
      i. ASTM C1173 - Specification for Flexible Transition Couplings for Underground Piping Systems.
      j. ASTM C1277 - Specification for Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
      k. ASTM C1460 - Specification for Shielded Transition Couplings for Use with Dissimilar DWV Pipe and Fittings Above Ground.
      l. ASTM C1540 - Specification for Heavy-Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
   4. Cast Iron Soil Pipe Institute (CISPI):
      a. CISPI 301 - Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.

b. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
c. Cast Iron Soil Pipe and Fittings Handbook, 2006.

5. Code of Federal Regulations (CFR):
   a. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings.
6. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS):
   a. MSS SP-69 - Pipe Hangers and Supports - Selection and Application.

1.04 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).
   2. Waste, Force-Main Piping: 50 psig (345 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

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
B. LEED® Submittals:
   1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.

1.06 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.

1.07 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

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.

2.02 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A74, Service class, coated.
B. Coatings: Chemically deposited zinc-phosphate pretreatment layer followed by high performance cathodic epoxy coating and high performance anodic epoxy top coat.
C. Gaskets: ASTM C564, rubber.
D. Calking Materials: ASTM B29, pure lead and oakum or hemp fiber.

2.03 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A888 or CISPI 301, coated.

B. Coatings: Chemically deposited zinc-phosphate pretreatment layer followed by high performance cathodic epoxy coating and high performance anodic epoxy top coat.

C. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ANACO-Husky.
   b. MIFAB, Inc.
   c. Mission Rubber Company; a division of MCP Industries, Inc.
   d. Approved Equal.
2. Standards: ASTM C1277 and ASTM C1540.
3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

2.04 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Unshielded, Nonpressure Transition Couplings:
   a. Manufacturers; Subject to compliance with requirements, provide products by one of the following:
      (1) Dallas Specialty & Mfg. Co.
      (2) Fernco, Inc.
      (3) Mission Rubber Company; a division of MCP Industries, Inc.
      (4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
   b. Standard: ASTM C1173.
   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. Sleeve Materials:
      (1) For Cast-Iron Soil Pipes: ASTM C564, rubber.
4. Shielded, Nonpressure Transition Couplings:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      (1) Cascade Waterworks Mfg. Co.
      (2) Mission Rubber Company; a division of MCP Industries, Inc.
      (3) Approved Equal.
   b. Standard: ASTM C1460.
   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.

PART 3 - EXECUTION

3.01 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in DIVISION 31.

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 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 22 05 48 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT.
K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. 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. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. 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 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 soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
    1. Underground Sanitary Drain: 2% downward in direction of flow for piping NPS 3 (DN 80) and smaller; 1% downward in direction of flow for piping NPS 4 (DN 100) and larger.
    2. Horizontal Sanitary Drainage Piping: 2% downward in direction of flow, unless indicated otherwise on drawings.
    3. Vent Piping: 1% down toward vertical fixture vent or toward vent stack.
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."
O. Install force mains at elevations indicated.

P. Plumbing Specialties:
   1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in SECTION 22 13 19 - SANITARY WASTE PIPING SPECIALTIES.
   2. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in SECTION 22 13 19 - SANITARY WASTE PIPING SPECIALTIES.

Q. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in SECTION 22 05 17 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING.

S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in SECTION 22 05 17 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING.

T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in SECTION 22 05 18 - ESCUTCHEONS FOR PLUMBING PIPING.

3.03 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.

C. 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.

D. 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.

3.04 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, 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.

3.05 VALVE INSTALLATION

A. General valve installation requirements are specified in SECTION 22 05 23 - GENERAL-DUTY VALVES FOR PLUMBING PIPING.

B. Shutoff Valves:
   1. Install shutoff valve on each sewage pump discharge.

2. Install gate or full-port ball valve for piping NPS 2 (DN 50) and smaller.
3. Install gate valve for piping NPS 2-1/2 (DN 65) and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

3.06 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices specified in SECTION 22 05 48 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT.

B. Comply with requirements for pipe hanger and support devices and installation specified in SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT and International Plumbing Code (IPC) 2018.
1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
3. Vertical Piping: MSS Type 8 or Type 42 clamps.
4. Install individual, straight, horizontal piping runs:
   a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
5. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support horizontal piping and tubing within 12 inches (300 mm) of each fitting, valve, and coupling.

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
2. NPS 3 (DN 80): 60 inches (1500 mm) with 1/2-inch (13-mm) rod.
3. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm) with 5/8-inch (16-mm) rod.
4. NPS 6 and NPS 8 (DN 150 and DN 200): 60 inches (1500 mm) with 3/4-inch (19-mm) rod.
5. NPS 10 and NPS 12 (DN 250 and DN 300): 60 inches (1500 mm) with 7/8-inch (22 mm) rod.
6. Spacing for 10-foot (3-m) lengths may be increased to 10 feet (3 m). Spacing for fittings is limited to 60 inches (1500 mm).

G. Install supports for vertical cast-iron soil piping every 15 feet (4.5 m).

H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4 (DN 32): 84 inches (2,100 mm) with 3/8-inch (10-mm) rod.
2. NPS 1-1/2 (DN 40): 108 inches (2,700 mm) with 3/8-inch (10-mm) rod.
3. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
4. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
5. NPS 3 (DN 80): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.
7. NPS 6 and NPS 8 (DN 150 and DN 200): 12 feet (3.7 m) with 3/4-inch (19-mm) rod.
8. NPS 10 and NPS 12 (DN 250 and DN 300): 12 feet (3.7 m) with 7/8-inch (22-mm) rod.

I. Install supports for vertical steel piping every 15 feet (4.5 m).

J. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

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 drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage 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 drainage 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 13 19 - SANITARY WASTE PIPING SPECIALTIES.
6. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 (DN 65) and larger.

D. Connect force-main piping to the following:

1. Sanitary Sewer: To exterior force main.
2. Sewage Pump: To sewage pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

F. 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. Comply with requirements for identification specified in SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT.

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 drainage 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. 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 drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent 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 to completion of inspection, water level must not drop. 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. 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). Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. 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. 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.

3.10 CLEANING AND PROTECTION

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.

3.11 PIPING SCHEDULE

A. Aboveground, soil and waste piping (<SS>) shall be the following:
Hubless, coated cast-iron soil pipe and fittings; CISPI heavy-duty hubless-piping couplings; and coupled joints.
B. Aboveground, vent piping (<V>) shall be the following:
1. Hubless, coated cast-iron soil pipe and fittings; CISPI heavy-duty hubless-piping couplings; and coupled joints.
C. Underground, soil, waste, and vent piping (<SS>) shall be the following:
1. Service class, coated cast-iron soil piping; gaskets; and gasketed joints.

END OF SECTION 22 13 16

SECTION 22 13 19 – 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.

1.02 SUMMARY

A. This SECTION includes:
   1. Adjust list below to suit Project.
   2. Cleanouts.
   3. Floor drains.
   4. Miscellaneous sanitary drainage piping specialties.

B. Related Requirements:
   1. SECTION 22 14 23 - STORM DRAINAGE PIPING SPECIALTIES for storm drainage piping inside the building, drainage piping specialties, and drains.
   2. DIVISION 33 for storm draining piping and piping specialties outside the building.

1.03 REFERENCES

A. Applicable Standards (Latest Edition):
   1. American Society of Sanitary Engineering (ASSE):
      a. ASSE 1050 - Stack Air Admittance Valves for Sanitary Drainage Systems.
      b. ASSE 1051 - Individual and Branch Type Air Admittance Valves for Sanitary Drainage Systems.
   2. ASME International (ASME):
      a. ASME A112.1.2 - Air Gaps in Plumbing Systems.
      b. ASME A112.3.1 - Performance Standard and Installation Procedures for Stainless Steel Drainage Systems for Sanitary, Storm and Chemical Applications, Above and Below Ground.
      c. ASME A112.6.3 - Floor and Trench Drains.
      d. ASME A112.14.1 - Backwater Valves.
      e. ASME A112.14.3 - Grease Interceptors.
      f. ASME A112.14.4 - Grease Removal Devices.
      g. ASME A112.21.2M - Roof Drains.
      h. ASME A112.36.2M - Cleanouts.
   3. ASTM International (ASTM):
      a. ASTM A48/A48M - Specification for Gray Iron Castings.
      b. ASTM A74 - Specification for Cast Iron Soil Pipe and Fittings.
      c. ASTM A653/A653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      d. ASTM B32 - Specification for Solder Metal.
      e. ASTM B152/B152M - Specification for Copper Sheet, Strip, Plate, and Rolled Bar.
      f. ASTM B749 - Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.
      g. ASTM C564 - Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
      h. ASTM D4068 - Specification for Chlorinated Polyethylene (CPE) Sheeting for Concealed Water-Containment Membrane.
   4. International Association of Plumbing and Mechanical Officials (IAPMO):

a. IAPMO PS 118 - FOG (Fats, Oils & Greases) Disposal Systems.
5. NFPA:
a. NFPA 70 - National Electrical Code.
6. NSF International (NSF):
a. NSF 14 - Plastics Piping Components and Related Materials.
7. Plumbing and Drainage Institute (PDI):
a. PDI-G101 - Testing and Rating Procedure for Grease Interceptors.
8. SSPC: The Society for Protective Coatings:
a. SSPC-Paint 12 - Paint Specification No. 12: Cold-Applied Asphalt Mastic (Extra Thick Film).
9. Underwriters Laboratories, Inc. (UL):
a. UL 1479 - Fire Tests of Through-Penetration Firestops.

1.04 ACTION SUBMITTALS

A. Shop Drawings: Show fabrication and installation details for frost-resistant vent terminals.

1.05 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.07 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
B. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.08 COORDINATION

A. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.01 CLEANOUTS

A. Exposed Metal Cleanouts <CO>:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Josam Company; Josam Div.
b. MIFAB, Inc.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products, Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Size: Same as connected drainage piping.
4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch or Hubless, cast-iron soil pipe test tee as required to match connected piping.

5. Closure: Countersunk plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Metal Floor Cleanouts <FCO-1>:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Josam Div.
   b. Oatey.
   c. Sioux Chief Manufacturing Company, Inc.
   d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   e. Tyler Pipe; Wade Div.
   f. Watts Drainage Products, Inc.
   g. Zurn Plumbing Products Group; Light Commercial Operation.
   h. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M for heavy-duty, adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Heavy-duty, adjustable housing.
5. Body or Ferrule: Cast-iron.
6. Clamping Device: Required.
7. Outlet Connection: Spigot or Threaded.
8. Closure: Brass plug with straight threads and gasket.
9. Adjustable Housing Material: Cast-iron.
10. Frame and Cover Material and Finish: Stainless-steel .
11. Frame and Cover Shape: Round.
12. Top Loading Classification: Heavy Duty.
13. Riser: ASTM A74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Metal Floor Cleanouts <FCO-2>:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Josam Div.
   b. Oatey.
   c. Sioux Chief Manufacturing Company, Inc.
   d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   e. Tyler Pipe; Wade Div.
   f. Watts Drainage Products, Inc.
   g. Zurn Plumbing Products Group; Light Commercial Operation.
   h. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M for heavy-duty, adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Heavy-duty, adjustable housing.
5. Body or Ferrule: Cast-iron.
6. Clamping Device: Required.
7. Outlet Connection: Spigot or Threaded.
8. Closure: Brass plug with straight threads and gasket.
9. Adjustable Housing Material: Cast-iron.
10. Frame and Cover Material and Finish: Stainless-steel.
11. Top Loading Classification: Extra-Heavy Duty.
12. Riser: ASTM A74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

D. Cast-Iron Wall Cleanouts <WCO>:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Josam Company; Josam Div.
b. MIFAB, Inc.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products, Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk, drilled-and-threaded brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

2.02 FLOOR DRAINS

A. Cast-Iron Floor Drains <FD-1>:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Commercial Enameling Co.
b. Josam Company; Josam Div.
c. MIFAB, Inc.
d. Prier Products, Inc.
e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
f. Tyler Pipe; Wade Div.
g. Watts Drainage Products, Inc.
h. Zurn Plumbing Products Group; Light Commercial Operation.
i. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Gray iron.
5. Anchor Flange: Required.
6. Clamping Device: Required.
7. Outlet: Bottom.
8. Backwater Valve: Not required.
9. Coating on Interior and Exposed Exterior Surfaces: Not required.
10. Sediment Bucket: Not required .
11. Top or Strainer Material: Stainless-steel.
12. Top of Body and Strainer Finish: Stainless-steel.
13. Top Shape: Round.
14. Dimensions of Top or Strainer: 6 inch.
15. Top Loading Classification: Light Duty.
16. Funnel: Not required.
17. Inlet Fitting: Not required.
18. Trap Material: Cast-iron.
19. Trap Pattern: Deep-seal P-trap.
20. Trap Features: Barrier type trap seal device.

B. Cast-Iron Floor Drains <FD-2>:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Commercial Enameling Co.
      b. Josam Company; Josam Div.
      c. MIFAB, Inc.
      d. Prier Products, Inc.
      e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
      f. Tyler Pipe; Wade Div.
      g. Watts Drainage Products, Inc.
      h. Zurn Plumbing Products Group; Light Commercial Operation.
      i. Zurn Plumbing Products Group; Specification Drainage Operation.
   2. Standard: ASME A112.6.3.
   3. Pattern: Floor sink.
   4. Body Material: Gray iron.
   5. Anchor Flange: Required.
   6. Clamping Device: Required.
   7. Outlet: Bottom.
   8. Backwater Valve: Not required.
   9. Coating on Interior and Exposed Exterior Surfaces: Porcelain enamel.
   10. Sediment Bucket: Not required.
   11. Top or Strainer Material: Nickel Bronze.
   12. Top of Body and Strainer Finish: Porcelain enamel.
   13. Top Shape: Square.
   14. Dimensions of Top or Strainer: 8 inch x 8 inch.
   15. Top Loading Classification: Medium Duty.
   16. Funnel: Not required.
   17. Inlet Fitting: Not required.
   18. Trap Material: Cast-iron.
   19. Trap Pattern: Deep-seal P-trap.
   20. Trap Features: Barrier type trap seal device.

C. Stainless-Steel Floor Drains <FS-1>:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Josam Company; Josam Div.
      b. Kusel Equipment Co.
      c. Scherping Systems, Inc.
      d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
      e. Tyler Pipe; Wade Div.
      f. Watts Drainage Products, Inc.
      g. Zurn Plumbing Products Group; Specification Drainage Operation.

   2. Standard: ASME A112.6.3.
   3. Outlet: Bottom.
   4. Top or Strainer Material: Stainless-steel.
   5. Top Shape: Square].
   6. Dimensions of Top or Strainer: 12 inch x12 inch.
   7. Seepage Flange: Not required.

8. Anchor Flange: Not required.
9. Clamping Device: Not required.
10. Trap-Primer Connection: Not required.
11. Trap Material: Cast-iron.
12. Trap Pattern: Deep-seal P-trap.

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. Air-Gap Fittings:
   1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
   2. Body: Bronze or cast iron.
   3. Inlet: Opening in top of body.
   4. Outlet: Larger than inlet.
   5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

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.

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 floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
   1. Position floor drains for easy access and maintenance.
   2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

E. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.
F. Assemble open drain fittings and install with top of hub 1 inch (25 mm) above floor.
G. Install deep-seal traps on floor drains and other waste outlets, if indicated.
H. Install barrier trap seal device on all floor and trench drains, unless indicated otherwise.
I. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
J. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
K. Install vent caps on each vent pipe passing through roof.
L. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch (25-mm) clearance between vent pipe and roof substrate.
M. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
N. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch (25-mm) clearance between vent pipe and roof substrate.
O. Install wood-blocking reinforcement for wall-mounting-type specialties.
P. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes, unless trap is indicated.

3.02 CONNECTIONS

A. Piping installation requirements are specified in other DIVISION 22 Sections. 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 DIVISION 26.
D. Connect wiring according to DIVISION 26.

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. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.04 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
B. Place plugs in ends of uncompleted piping at end of each day or when Work stops.

END OF SECTION 22 13 19

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SECTION 22 42 13.13 – COMMERCIAL WATER CLOSETS

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:
   1. Water closets.
   2. Flushometer valves.
   3. Toilet seats.

B. Related Requirements:
   1. SECTION 22 43 00 - HEALTHCARE PLUMBING FIXTURES.

1.03 REFERENCES:

A. Applicable Standards (Latest Edition):
   1. American Society of Sanitary Engineering (ASSE):
      a. ASSE 1037 - Pressurized Flushing Devices (Flushometers) for Plumbing Fixtures.
   2. ASME International (ASME):
      a. ASME A112.4.3 - Plastic Fittings for Connecting Water Closets to the Sanitary Drainage System.
      b. ASME A112.6.1M - Floor-Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use.
      c. ASME A112.19.5 - Trim for Water Closet Bowls, Tanks, and Urinals.
   3. ASME International/Canadian Standards Association (ASME/CSA):
      a. ASME A112.19.2/CSA B45.1 - Ceramic Plumbing Fixtures.
   4. ASTM International (ASTM):
      a. ASTM A1045 - Specification for Flexible Poly (Vinyl Chloride) (PVC) Gaskets Used in Connection of Water Closets to Sanitary Drainage Systems.
   5. International Association of Plumbing and Mechanical Officials/American National Standards Institute (IAPMO/ANSI):
      a. IAPMO/ANSI Z124.5 - Plastic Toilet (Water Closet) Seats.
   6. International Code Council/American National Standards Institute (ICC/ANSI):
      a. ICC/ANSI A117.1 - Accessible and Usable Buildings and Facilities.
   7. International Plumbing Code (IPC) - 2015
   8. NFPA:
      a. NFPA 70 - National Electrical Code.
   9. Underwriters Laboratories, Inc. (UL):
      a. UL 1951 - Electric Plumbing Accessories.

1.04 ACTION SUBMITTALS:

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water closets.
      Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.05 CLOSEOUT SUBMITTALS:

A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

1.06 MAINTENANCE MATERIAL SUBMITTALS:

A. Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents.
   1. Flushometer-Valve Repair Kits: Equal to 10% of amount of each type installed, but no fewer than one of each type.

PART 2 - PRODUCTS

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2.02 FLOOR-MOUNTED, BACK-OUTLET WATER CLOSETS:

A. Water Closets <WC-1>: Floor mounted, back outlet, top spud, accessible.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Standard America.
      b. Kohler Co.
   2. Bowl:
      a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
      b. Material: Vitreous china with antimicrobial finish.
      c. Type: Siphon jet.
      d. Style: Flushometer valve.
      e. Height: ADA.
      f. Rim Contour: Elongated.
      g. Water Consumption: 1.6 gal. per flush.
      h. Spud Size and Location: NPS 1-1/2 ; top.
      i. Color: White.
   3. Flushometer Valve: <FV-1>.
   4. Toilet Seat: <TS-1>.
   5. Support:
      a. Standard: ASME A112.6.1M.
      b. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture.

B. Water Closets <WC-2>: Floor mounted, bottom outlet, top spud, accessible.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Standard America.
      b. Kohler Co.
   2. Bowl:
      a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
      b. Material: Vitreous china with antimicrobial finish.
      c. Type: Siphon jet.
      d. Style: Flushometer valve.
      e. Height: ADA.

f. Rim Contour: Elongated.
g. Water Consumption: 1.6 gal. per flush.
h. Spud Size and Location: NPS 1-1/2 ; top.
i. Color: White.

3. Flushometer Valve: <FV-1>.
4. Toilet Seat: <TS-1>.
5. Support:
   a. Standard: ASME A112.6.1M.
   b. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture.

C. Water Closets <WC-3>: Floor mounted, bottom outlet, top spud, accessible.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard America.
   b. Kohler Co.
2. Bowl:
   a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
   b. Material: Vitreous china with antimicrobial finish.
   c. Type: Siphon jet.
   d. Style: Flushometer valve.
   e. Height: ADA.
   f. Rim Contour: Elongated with bedpan lugs.
   g. Water Consumption: 1.6 gal. per flush.
   h. Spud Size and Location: NPS 1-1/2 ; top.
   i. Color: White.
3. Flushometer Valve: <FV-2>.
4. Toilet Seat: <TS-1>.
5. Support:
   a. Standard: ASME A112.6.1M.
   b. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture.

D. Water Closets <WC-4>: Floor mounted, back outlet, top spud, accessible.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard America.
   b. Kohler Co.
2. Bowl:
   a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
   b. Material: Vitreous china with antimicrobial finish.
   c. Type: Siphon jet.
   d. Style: Flushometer valve.
   e. Height: ADA.
   f. Rim Contour: Elongated with bedpan lugs.
   g. Water Consumption: 1.6 gal. per flush.
   h. Spud Size and Location: NPS 1-1/2 ; top.
   i. Color: White.

3. Flushometer Valve: <FV-2>.
4. Toilet Seat: <TS-1>.
5. Support:
    a. Standard: ASME A112.6.1M.
    b. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture.

2.03 FLUSHOMETER VALVES:

A. Battery-Powered, Solenoid-Actuator, Piston Flushometer Valves <FV-1>:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Zurn Industries, LLC; Commercial Brass and Fixtures.
2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig .
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Style: Exposed.
8. Actuator: Solenoid complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
9. Trip Mechanism: Battery-powered electronic sensor complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
10. Consumption: 1.6 gal. per flush.
11. Minimum Inlet: NPS 1 .
12. Minimum Outlet: NPS 1-1/4 .
13. Accessories: Batteries as required for operation.

B. Lever-Handle, Piston Flushometer Valves, Bedpan Washer <FV-2>:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Sloan Valve Company.
    b. TOTO USA, Inc.
    c. Zurn Industries, LLC; Commercial Brass and Fixtures.
2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig.
4. Features: Include offset flush tube, ntegral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated with antimicrobial coating.
7. Style: Exposed.
8. Bedpan Washer: Integral, fold-down with support.
9. Consumption: 1.6 gal. per flush.
10. Minimum Inlet: NPS 1 .
11. Minimum Outlet: NPS 1-1/4 .

2.04 TOILET SEATS:

A. Toilet Seats <TS-1>:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard America.
   b. TOTO USA, Inc.
   c. Zurn Industries, LLC; Commercial Brass and Fixtures.
2. Standard: IAPMO/ANSI Z124.5.
3. Material: Plastic.
4. Type: Commercial (Heavy Duty).
5. Shape: Elongated rim, open front.
6. Hinge: Check.
7. Hinge Material: Noncorroding metal.
8. Seat Cover: Not required.
9. Color: White.

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 water closet installation.
B. Examine walls and floors for suitable conditions where water closets will be installed.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:

A. Water Closet Installation:
   1. Install level and plumb according to roughing-in Drawings.
   2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.
B. Support Installation:
   1. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.
   2. Use carrier supports with waste-fitting assembly and seal.
   3. Install floor-mounted, back-outlet water closets attached to building floor substrate, onto waste-fitting seals; and attach to support.
C. Flushometer Valve Installation:
   1. Install flushometer valve, water supply fitting on each supply to each water closet.
   2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
   3. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
   4. Install actuators in locations that are easy for people with disabilities to reach.
   5. Install fresh batteries in battery-powered, electronic-sensor mechanisms.
D. Install toilet seats on water closets.
E. Wall Flange and Escutcheon Installation:
   1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
   2. Install deep-pattern escutcheons if required to conceal protruding fittings.
   3. Comply with escutcheon requirements specified in SECTION 22 05 18 - ESCUTCHEONS FOR PLUMBING PIPING.
F. Joint Sealing:

1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to water closet color.
3. Comply with sealant requirements specified in DIVISION 07.

3.03 CONNECTIONS:

A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.
B. Comply with water piping requirements specified in SECTION 22 11 16 - DOMESTIC WATER PIPING.
C. Comply with soil and waste piping requirements specified in SECTION 22 13 16 - SANITARY WASTE AND VENT PIPING.
D. Where installing piping adjacent to water closets, allow space for service and maintenance.

3.04 ADJUSTING:

A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.
B. Adjust water pressure at flushometer valves to produce proper flow.
C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.05 CLEANING AND PROTECTION:

A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.
B. Install protective covering for installed water closets and fittings.
C. Do not allow use of water closets for temporary facilities, unless approved in writing by Owner.

END OF SECTION 22 42 13.13

SECTION 22 42 13.16 – COMMERCIAL URINALS

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:
   1. Urinals.
   2. Flushometer valves.

1.03 REFERENCES:

A. Applicable Standards (Latest Edition):
   1. American National Standards Institute (ANSI):
      a. ANSI Z124.9 - Plastic Urinal Fixtures.
   2. American Society of Sanitary Engineering (ASSE):
      a. ASSE 1037 - Pressurized Flushing Devices (Flushometers) for Plumbing Fixtures.
   3. ASME International (ASME):
      a. ASME A112.6.1M - Floor-Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use.
      b. ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals.
   4. ASME International/Canadian Standards Association (ASME/CSA):
      a. ASME A112.18.1/CSA B125.1 - Plumbing Supply Fittings.
      b. ASME A112.18.2/CSA B125.2 - Plumbing Waste Fittings.
      c. ASME A112.19.1-2008/CSA B45.2 - Enameled Cast Iron and Enameled Steel Plumbing Fixtures.
      d. ASME A112.19.2-2008/CSA B45.1 - Ceramic Plumbing Fixtures.
   5. International Code Council/American National Standards Institute (ICC/ANSI):
      a. ICC/ANSI A117.1 - Accessible and Usable Buildings and Facilities (ANSI).
   6. International Plumbing Code (IPC) - 2015
   7. NFPA:
      a. NFPA 70 - National Electrical Code.
   8. Underwriters Laboratories, Inc. (UL):
      a. UL 1951 - Electric Plumbing Accessories.

1.04 ACTION SUBMITTALS:

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for urinals.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.05 CLOSEOUT SUBMITTALS:

A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

1.06 MAINTENANCE MATERIAL SUBMITTALS:

A. Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents.
   1. Flushometer-Valve Repair Kits: Equal to 20% of amount of each type installed, but no fewer than one of each type.

PART 2 - PRODUCTS

2.01 WALL-HUNG URINALS:

A. Urinals <UR-1>: Wall hung, back outlet, siphon jet, accessible.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Standard America.
      b. Kohler Co.
      c. Crane Plumbing.
   2. Fixture:
      a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
      b. Material: Vitreous china.
      c. Type: Siphon jet .
      d. Strainer or Trapway: Manufacturer's standard strainer with integral trap.
      e. Water Consumption: Water saving, 0.5 gallons per flush. WaterSense Labeled.
      f. Spud Size and Location: NPS 3/4 ; top.
      g. Outlet Size and Location: NPS 2 ; back.
      h. Color: White.
   3. Flushometer Valve: <FV-1>.
   4. Waste Fitting:
      a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
      b. Size: NPS 2 .
   5. Support: ASME A112.6.1M, Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture.

B. Urinals <UR-2>: Wall hung, back outlet, siphon jet.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Standard America.
      b. Kohler Co.
      c. Crane Plumbing.
   2. Fixture:
      a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
      b. Material: Vitreous china.
      c. Type: Siphon jet.
      d. Strainer or Trapway: Manufacturer's standard strainer with integral trap.
      e. Water Consumption: Water saving, 0.5 gallons per flush. WaterSense Labeled.
      f. Spud Size and Location: NPS 3/4 ; top.
      g. Outlet Size and Location: NPS 2 ; back.
      h. Color: White.
   3. Flushometer Valve: <FV-1>.
   4. Waste Fitting:
      a. Standard: ASME A112.18.2/CSA B125.2 for coupling.

b. Size: NPS 2.

5. Support: ASME A112.6.1M, Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture.

2.02 URINAL FLUSHOMETER VALVES:

A. Battery-Powered, Solenoid-Actuator, Piston Flushometer Valves <FV-1>:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Sloan Valve Company.
   b. Zurn Industries, LLC; Commercial Brass and Fixtures.
   c. TOTO USA, Inc.
2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig.
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Style: Exposed
8. Actuator: Solenoid complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
9. Trip Mechanism: Battery-powered electronic sensor complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
10. Consumption: 0.5 gal. per flush.
11. Minimum Inlet: NPS 3/4 .
12. Minimum Outlet: NPS 3/4 .
13. Accessories: Batteries as required for operation.

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 urinal installation.
B. Examine walls and floors for suitable conditions where urinals will be installed.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:

A. Urinal Installation:
   1. Install urinals level and plumb according to roughing-in Drawings.
   2. Install wall-hung, back-outlet urinals onto waste fitting seals and attached to supports.
   3. Install accessible, wall-mounted urinals at mounting height for the handicapped/elderly, according to ICC/ANSI A117.1.
B. Support Installation:
   1. Install supports, affixed to building substrate, for wall-hung urinals.
   2. Use off-floor carriers with waste fitting and seal for back-outlet urinals.
   3. Use chair-type carrier supports with rectangular steel uprights for accessible urinals.
C. Flushometer-Valve Installation:
   1. Install flushometer-valve water-supply fitting on each supply to each urinal.

2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

D. Wall Flange and Escutcheon Installation:
1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.
3. Comply with escutcheon requirements specified in SECTION 22 05 18 - ESCUTCHEONS FOR PLUMBING PIPING.

E. Joint Sealing:
1. Seal joints between urinals, walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to urinal color.
3. Comply with sealant requirements specified in DIVISION 07.

3.03 CONNECTIONS:

A. Connect urinals with water supplies and soil, waste, and vent piping. Use size fittings required to match urinals.
B. Comply with water piping requirements specified in SECTION 22 11 16 - DOMESTIC WATER PIPING.
C. Comply with soil and waste piping requirements specified in SECTION 22 13 16 - SANITARY WASTE AND VENT PIPING.
D. Where installing piping adjacent to urinals, allow space for service and maintenance.

3.04 ADJUSTING:

A. Operate and adjust urinals and controls. Replace damaged and malfunctioning urinals, fittings, and controls.
B. Adjust water pressure at flushometer valves to produce proper flow.
C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.05 CLEANING AND PROTECTION:

A. Clean urinals and fittings with manufacturers' recommended cleaning methods and materials.
B. Install protective covering for installed urinals and fittings.
C. Do not allow use of urinals for temporary facilities, unless approved in writing by Owner.

END OF SECTION 22 42 13.16

SECTION 22 42 16.13 – COMMERCIAL LAVATORIES

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:
   1. Lavatories.
   2. Faucets.

1.03 REFERENCES:

A. Applicable Standards (Latest Edition):
   1. American National Standards Institute/International Cast Polymer Association (ANSI/ICPA):
      a. ANSI/ICPA SS-1 - Performance Standard for Solid Surface Materials.
   2. ASME International (ASME):
      a. ASME A112.6.1M - Floor-Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use.
      b. ASME A112.18.3 - Performance Requirements for Backflow Protection Devices and Systems in Plumbing Fixture Fittings.
      c. ASME A112.18.6 - Flexible Water Connectors.
   3. ASME International/Canadian Standards Association (ASME/CSA):
      a. ASME A112.18.1/CSA B125.1 - Plumbing Supply Fittings.
      b. ASME A112.18.2/CSA B125.2 - Plumbing Waste Fittings.
      c. ASME A112.19.2/CSA B45.1 - Ceramic Plumbing Fixtures.
   4. International Code Council/American National Standards Institute (ICC/ANSI):
      a. ICC/ANSI A117.1 - Accessible and Usable Buildings and Facilities.
   5. NSF International/American National Standards Institute (NSF/ANSI):
      a. NSF/ANSI 61 - Drinking Water System Components - Health Effects.
   6. Underwriters Laboratories, Inc. (UL):
      a. UL 1951 - Electric Plumbing Accessories.

1.04 ACTION SUBMITTALS:

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for lavatories.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: Include diagrams for power, signal, and control wiring of automatic faucets.

1.05 CLOSEOUT SUBMITTALS:

A. Operation and Maintenance Data: For lavatories and faucets to include in operation and maintenance manuals.
   1. In addition to items specified in DIVISION 01, include the following:
      a. Servicing and adjustments of automatic faucets.

1.06 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. Faucet Washers and O-Rings: Equal to 20% of amount of each type and size installed.
   2. Faucet Cartridges and O-Rings: Equal to 10% of amount of each type and size installed.

PART 2 - PRODUCTS

2.01 SOLID SURFACE, COUNTER-MOUNTED LAVATORIES:

A. Lavatory <LAV-2>: Rectangular, solid surface, undercounter mounted.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings:
      a. Corian 8254.
   2. Fixture:
      a. Standard: ASME A112.19.2/CSA B45.1.
      b. Type: Undercounter mounting.
      c. Nominal Size: Rectangular, 19-1/2 by 14-3/8 inches .
      d. Faucet-Hole Location: Top.
      e. Color: White.
      f. Mounting Material: Sealant.
   3. Faucet: <F-1> or <F-2>.

2.02 VITREOUS-CHINA, WALL-MOUNTED LAVATORIES:

A. Lavatory <LAV-1>: Vitreous china, wall mounted, with back outlet.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Standard America.
      b. TOTO USA, Inc.
      c. Zurn Industries, LLC; Commercial Brass and Fixtures.
   2. Fixture:
      a. Standard: ASME A112.19.2/CSA B45.1.
      b. Type: For wall hanging.
      c. Nominal Size: Oval, 20-1/2 by 21-1/4 inches (520 by 540 mm).
      d. Faucet-Hole Punching: Three holes, 4-inch (102-mm) centers.
      e. Faucet-Hole Location: Top.
      f. Color: White.
      g. Accessories: Vitreous china shroud/knee contact guard.
   3. Faucet: <F-1> or <F-2>.
   4. Support: ASME A112.6.1M, Type II, concealed-arm lavatory carrier with escutcheons.

2.03 MANUALLY OPERATED FAUCETS:

A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water.

B. Lavatory Faucets <F-2>: Manual-type, two-handle mixing, commercial, solid-brass valve.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Chicago Faucets.
      b. T & S Brass and Bronze Works, Inc.

c. Zurn Industries, LLC; Commercial Brass and Fixtures.
2. Standard: ASME A112.18.1/CSA B125.1.
3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
4. Body Type: 4" Centerset.
5. Body Material: Commercial, solid brass.
6. Cartridge: Ceramic 1/4-turn operation.
7. Finish: Polished chrome plate.
8. Maximum Flow Rate: 0.5 gpm (1.5 L/min.).
9. Mounting Type: Deck, exposed.
10. Valve Handle(s): Wrist blade, 4 inches (102 mm).
11. Spout: Rigid type.
12. Spout Outlet: Non-aerating laminar flow.
13. Drain: Not part of faucet.

2.04 AUTOMATICALLY OPERATED LAVATORY FAUCETS:

A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water.
B. Lavatory Faucets <F-1>: Automatic-type, battery powered, electronic-sensor-operated, mixing, solid-brass valve.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Chicago Faucets.
b. T & S Brass and Bronze Works, Inc.
c. Zurn Industries, LLC; Commercial Brass and Fixtures.
2. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.
3. 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.
4. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
5. Body Type: Single hole.
6. Body Material: Commercial, solid brass.
7. Finish: Polished chrome plate.
8. Maximum Flow Rate: 0.5 gpm.
9. Mounting Type: Deck, concealed.
10. Spout: Rigid type.
11. Spout Outlet: Non-aerating laminar flow.
12. Drain: Not part of faucet.
13. Accessories: Batteries as required for operation.

2.05 SUPPLY FITTINGS:

A. NSF Standard: Comply with NSF/ANSI 61, "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: Wheel handle.
F. Risers:
   1. Per Schedule .
   2. ASME A112.18.6, braided or corrugated stainless-steel, flexible hose riser.

2.06 WASTE FITTINGS:
A. Standard: ASME A112.18.2/CSA B125.2.
B. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.
C. Trap:
   1. Size: NPS 1-1/2.
   2. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch thick brass tube to wall; and chrome-plated, brass or steel wall flange.

PART 3 - EXECUTION

3.01 EXAMINATION:
A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before lavatory installation.
B. Examine counters and walls for suitable conditions where lavatories will be installed.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:
A. Install lavatories level and plumb according to roughing-in Drawings.
B. Install supports, affixed to building substrate, for wall-mounted lavatories.
C. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1.
D. Install water-supply piping with stop on each supply to each sink faucet.
   1. Exception: Use ball, gate, or globe valves if supply stops are not specified with sink. Comply with valve requirements specified in SECTION 22 05 23 - GENERAL-DUTY VALVES FOR PLUMBING PIPING.
   2. Install stops in locations where they can be easily reached for operation.
E. Install water-supply piping with check valve on hot water supply to all mop basin service sinks and upstream of any thermostatic mixing valve. Locate check valve downstream of service valve to branch unless indicated otherwise.
F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in SECTION 22 05 18 - ESCUTCHEONS FOR PLUMBING PIPING.
G. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in DIVISION 07.
H. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in SECTION 22 07 19 - PLUMBING PIPING INSULATION.

3.03 CONNECTIONS:

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
B. Comply with water piping requirements specified in SECTION 22 11 16 - DOMESTIC WATER PIPING.
C. Comply with soil and waste piping requirements specified in SECTION 22 13 16 - SANITARY WASTE AND VENT PIPING.

3.04 ADJUSTING:

A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.
B. Adjust water pressure at faucets to produce proper flow.
C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.05 CLEANING AND PROTECTION:

A. After completing installation of lavatories, inspect and repair damaged finishes.
B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
C. Provide protective covering for installed lavatories and fittings.
D. Do not allow use of lavatories for temporary facilities, unless approved in writing by Owner.

END OF SECTION 22 42 16.13

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SECTION 22 42 16.16 – COMMERCIAL SINKS

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:
   1. Service basins.
   2. Utility sinks.
   3. Handwash sinks.
   4. Sink faucets.
   5. Supply fittings.
   6. Waste fittings.

1.03 REFERENCES:

A. Applicable Standards (Latest Edition):
   1. ASME International (ASME):
      a. ASME A112.6.1M - Floor-Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use.
      b. ASME A112.18.6 - Flexible Water Connectors.
      c. ASME B1.20.7 - Hose Coupling Screw Threads (Inch).
   2. ASME International/Canadian Standards Association (ASME/CSA):
      a. ASME A112.18.1/CSA B125.1 - Plumbing Supply Fittings.
      b. ASME A112.18.2/CSA B125.2 - Plumbing Waste Fittings.
      c. ASME A112.19.1/CSA B45.2 - Enameled Cast-Iron and Enameled Steel Plumbing Fixtures.
      d. ASME A112.19.2/CSA B45.1 - Ceramic Plumbing Fixtures.
      e. ASME A112.19.3/CSA B45.4 - Stainless-Steel Plumbing Fixtures.
   3. ASTM International (ASTM):
      a. ASTM C1107/C1107M - Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
   4. International Association of Plumbing and Mechanical Officials (IAPMO):
      a. IAPMO PS 99 - Terrazzo, Marble, Concrete, Granite, and Slate Plumbing Fixtures.
   5. International Association of Plumbing and Mechanical Officials/American National Standards Institute (IAPMO/ANSI):
      a. IAPMO/ANSI Z124.6 - Plastic Sinks.
   6. International Code Council/American National Standards Institute (ICC/ANSI):
      a. ICC/ANSI A117.1 - Accessible and Usable Buildings and Facilities.
   7. NSF International/American National Standards Institute (NSF/ANSI):
      a. NSF/ANSI 2 - Food Equipment.
      b. NSF/ANSI 61 - Drinking Water System Components - Health Effects.

1.04 ACTION SUBMITTALS:

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sinks.

2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.05 INFORMATIONAL SUBMITTALS:

A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

1.06 CLOSEOUT SUBMITTALS:

A. Maintenance Data: For sinks to include in 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. Faucet Washers and O-Rings: Equal to 10% of amount of each type and size installed.
   2. Faucet Cartridges and O-Rings: Equal to 5% of amount of each type and size installed.

PART 2 - PRODUCTS

2.01 SERVICE BASINS:

A. Service Basins <MB-1>: Terrazzo, floor mounted.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Acorn Engineering Company.
      b. Crane Plumbing, LLC.
      c. Florestone Products Co., Inc.
      d. Stern-Williams Co., Inc.
      e. Zurn Industries, LLC; Commercial Brass and Fixtures.
   2. Fixture:
      a. Standard: IAPMO PS 99.
      b. Shape: Rectangular.
      c. Nominal Size: 24 by 24 inches (610 by 610 mm .
      d. Height: 12 inches (305 mm).
      e. Tiling Flange: Not required.
      f. Rim Guard: Cast integral, on all top surfaces.
      g. Color: Pearl grey marble chips in smooth, white portland cement.
      h. Drain: Grid with NPS 3 outlet.
   3. Mounting: On floor and flush to wall.
   4. Faucet: <F-1>.
   5. Accessories: 12” high, 3-sided, 304SS wall protection.

2.02 UTILITY SINKS:

A. Utility Sinks <SK-1>: Thermoplastic, freestanding.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Advance Tabco.
      b. Eagle Group; Foodservice Equipment Division.
      c. Elkay Manufacturing Co.
      d. Griffin Products, Inc.

e. Just Manufacturing.
f. E.L. Mustee.

2. Fixture:
   a. Standard: ASME A112.19.3/CSA B45.4.
   b. Type: Ledge back.
   c. Number of Compartments: One.
   d. Overall Dimensions: 34” x 20” x 24”.
3. Faucet(s): Included with Fixture.
   a. Number Required: One.
   b. Mounting: On ledge.
4. Supply Fittings:
   a. Standard: ASME A112.18.1/CSA B125.1.
   b. Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.
      (1) Risers: NPS 1/2 (DN 15), chrome-plated, rigid-copper pipe.
5. Waste Fittings:
   a. Standard: ASME A112.18.2/CSA B125.2.
   b. Trap(s):
      (1) Size: NPS 2 (DN 50).
      (2) Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032 inch (0.83 mm) thick brass tube to wall ; and chrome-plated brass or steel wall flange.
6. Mounting: Floor.

2.03 HANDWASH SINKS:

A. Handwash Sinks <SK-2>: Stainless steel, counter mounted.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings:
      a. Elkay Manufacturing Co.
   2. Fixture:
      a. Standards: ASME A112.19.3/CSA B45.4 and NSF/ANSI 2.
      b. Type: Basin with radius corners, back for faucet.
      c. Nominal Size: 19-1/2 by 19 by 6-1/2 inches.
   3. Faucet: <F-2> <F-3>. See Schedule
   4. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
   5. Waste Fittings: Comply with requirements in "Waste Fittings" Article.
   6. Support: N/A.

B. Handwash Sinks <SK-6, SK-7>: Stainless steel, counter mounted.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings:
      a. Elkay Manufacturing Co.
   2. Fixture:
      a. Standards: ASME A112.19.3/CSA B45.4 and NSF/ANSI 2.
      b. Type: Basin with radius corners, back for faucet.
      c. Nominal Size: 19-1/2 by 19 by 10-3/16 inches.
   3. Faucet: <F-2> <F-3>. See Schedule
   4. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
   5. Waste Fittings: Comply with requirements in "Waste Fittings" Article.

6. Support: N/A.

C. Handwash Sinks <SK-8>: Solid surface, counter drop-in.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings:
      a. Kohler Bolero Oval
   2. Fixture:
      a. Standards: ASME A112.19.3/CSA B45.4 and NSF/ANSI 2.
      b. Type: Oval basin.
      c. Nominal Size: 16-3/4 by 11-3/4 by 6 inches.
   3. Faucet: <F-2> <F-3>. See Schedule
   4. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
   5. Waste Fittings: Comply with requirements in "Waste Fittings" Article.
   6. Support: N/A.

2.04 SPECIALITY SINKS:

A. Clinical Sinks <SK-3>: Vitreous china, floor mounted.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Standard America.
      b. TOTO USA, Inc.
      c. Zurn Industries, LLC; Commercial Brass and Fixtures.
   2. Fixture:
      a. Standards: ASME A112.19.2M.
      b. Type: Flushing rim, siphon jet.
      c. Nominal Size: 29-1/4 by 30 by 18 inches.
   3. Faucet: <F-4>.
   4. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
   5. Waste Fittings: Comply with requirements in "Waste Fittings" Article.
   6. Support: Pedestal Base with radiused edges on exposed surfaces.

B. Hairwash Sinks <SK-9>: Porcelain, shampoo bowl.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings:
      a. Jeffco 8700 Tilting.
   2. Fixture:
      a. Standards: ASME A112.19.3/CSA B45.4 and NSF/ANSI 2.
      b. Type: Tilting Basin.
      c. Nominal Size: 24 by 21 by 10 inches.
   3. Faucet: Included 570 Faucet, Vacuum Break, Hose.
   4. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
   5. Waste Fittings: Comply with requirements in "Waste Fittings" Article.
   6. Support: N/A.

C. Cup Sink Sinks <SK-10>: Polyethylene, cup sink.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings:
      a. Watts – Orion CS1-6x3x4.
   2. Fixture:
      a. Material: Virgin, high-density black polyethylene.
      b. Type: Drop-In.

c. Nominal Size: 6 by 3 by 4 inches.
3. Faucet: None.
4. Supply Fittings: None.
5. Waste Fittings: 1-1/2in.
6. Support: N/A.

D. Laundry Sinks <SK-11>: Stainless steel, freestanding with backsplash.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Just Manufacturing.
b. Acorn Engineering Company, Inc.
c. Engineer Approved equal
2. Fixture:
a. Standards: ASME A112.19.3/CSA B45.4 and NSF/ANSI 2.
b. Type: Freestanding.
c. Nominal Size: 24 by 24by 12 inches.
d. Backsplash: 12” integral.
3. Faucet: <F-5>
4. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
5. Waste Fittings: Comply with requirements in "Waste Fittings" Article.
6. Support: N/A.

2.05 SINK FAUCETS:

A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for faucet-spout materials that will be in contact with potable water.

B. Sink Faucets <F-1>: Manual type, two-lever-handle mixing valve.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Chicago Faucets.
b. T & S Brass and Bronze Works, Inc.
c. Zurn Industries, LLC; Commercial Brass and Fixtures.
2. Standard: ASME A112.18.1/CSA B125.1.
3. General: Include hot- and cold-water indicators; integral check valves; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
4. Body Type: Widespread.
5. Body Material: Commercial, solid brass.
6. Finish: Chrome plated.
7. Maximum Flow Rate: 2.0 gpm (8.3 L/min.).
8. Handle(s): Lever.
9. Mounting Type: Back/wall, exposed.
10. Spout Type: Rigid, solid brass with wall brace and pail hook.
11. Vacuum Breaker: Required for hose outlet.
12. Spout Outlet: Laminar flow Hose thread according to ASME B1.20.7.

C. Sink Faucets <F-2>: Manual-type, two-handle mixing, commercial, solid-brass valve.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Chicago Faucets.
b. T & S Brass and Bronze Works, Inc.

c. Zurn Industries, LLC; Commercial Brass and Fixtures.
2. Standard: ASME A112.18.1/CSA B125.1.
3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
4. Body Type: 4" Centerset.
5. Body Material: Commercial, solid brass.
6. Cartridge: Ceramic 1/4-turn operation.
7. Finish: Polished chrome plate.
8. Maximum Flow Rate: 1.5 gpm (5.6 L/min.).
9. Mounting Type: Deck, exposed.
10. Valve Handle(s): Wrist blade, 4 inches (102 mm).
11. Spout: Non-Swivel.
12. Spout Outlet: Non-aerating laminar flow.
13. Drain: Not part of faucet.

D. Sink Faucets <F-3>: Automatic-type, battery powered, electronic-sensor-operated, mixing, solid-brass valve.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Chicago Faucets.
b. T & S Brass and Bronze Works, Inc.
c. Zurn Industries, LLC; Commercial Brass and Fixtures.
2. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.
3. 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.
4. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
5. Body Type: Single hole.
6. Body Material: Commercial, solid brass.
7. Finish: Polished chrome plate.
8. Maximum Flow Rate: 1.5 gpm (5.6 L/min) .
9. Mounting Type: Deck, concealed.
10. Spout: Non-Swivel.
11. Spout Outlet: Non-aerating laminar.
12. Drain: Not part of faucet.
13. Accessories: Batteries as required for operation.

E. Clinical Sink Faucets <F-4>: Exposed Flush Valve with Bedpan Washer and Service Sink Faucet.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Sloan Valve Company.
b. T & S Brass and Bronze Works, Inc.
c. Zurn Industries, LLC; Commercial Brass and Fixtures.
2. Standard: ASME A112.18.1/CSA B125.1 and ASSE 1037.
3. Minimum Pressure Rating: 125 psig .
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated with antimicrobial finish.

7. Style: Exposed.
8. Bedpan Washer: Integral, fold-down.
9. Consumption: 6.5 gal. per flush.
10. Minimum Inlet: NPS 1 .
11. Minimum Outlet: NPS 1-1/4 .
12. Faucet Body Material: Commercial, solid brass.
13. Cartridge: Ceramic 1/4-turn operation.
14. Finish: Polished chrome plate.
15. Maximum Flow Rate: 1.5 gpm (5.6 L/min.).
16. Mounting Type: Wall, exposed.
17. Valve Handle(s): Wrist blade, 4 inches (102 mm).
18. Spout: Rigid type with brace.
19. Spout Outlet: Hose Connection.
20. Drain: Not part of faucet.

F. Sink Faucets <F-5>: Manual-type, two-handle mixing, commercial, solid-brass valve.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Chicago Faucets.
   b. T & S Brass and Bronze Works, Inc.
   c. Zurn Industries, LLC; Commercial Brass and Fixtures.
2. Standard: ASME A112.18.1/CSA B125.1.
3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
4. Body Type: 4” Centerset, wall mount.
5. Body Material: Commercial, solid brass.
6. Cartridge: Ceramic 1/4-turn operation.
7. Finish: Polished chrome plate.
8. Maximum Flow Rate: 1.5 gpm (5.6 L/min.).
9. Mounting Type: Deck, exposed.
10. Valve Handle(s): Wrist blade, 4 inches (102 mm).
11. Spout: 9-1/2” swing spout.
12. Spout Outlet: Aerator.
13. Drain: Not part of faucet.

2.06 SUPPLY FITTINGS:

A. NSF Standard: Comply with NSF/ANSI 61, "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: Wheel handle.
F. Risers:
1. Per Schedule.
2. ASME A112.18.6, braided or corrugated stainless-steel flexible hose.

2.07 WASTE FITTINGS:

A. Standard: ASME A112.18.2/CSA B125.2.
B. Drain: Grid type with NPS 1-1/2 (DN 40) offset and straight tailpiece.
C. Trap:
   1. Size: Per Schedule.
   2. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch (0.83-mm) thick brass tube to wall; and chrome-plated brass or steel wall flange.

2.08 GROUT:

A. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
B. Characteristics: Nonshrink; recommended for interior and exterior applications.
C. Design Mix: 5,000 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 sink installation.
B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:

A. Install sinks level and plumb according to roughing-in Drawings.
B. Install supports, affixed to building substrate, for wall-hung sinks.
C. Install accessible wall-mounted sinks at handicapped/elderly mounting height according to ICC/ANSI A117.1.
D. Set floor-mounted sinks in leveling bed of cement grout.
E. Install water-supply piping with stop on each supply to each sink faucet.
   1. Exception: Use ball, gate, or globe valves if supply stops are not specified with sink. Comply with valve requirements specified in SECTION 22 05 23 - GENERAL-DUTY VALVES FOR PLUMBING PIPING.
   2. Install stops in locations where they can be easily reached for operation.
F. Install water-supply piping with check valve on hot water supply to all mop basin service sinks and upstream of any thermostatic mixing valve. Locate check valve downstream of service valve to branch unless indicated otherwise.
G. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in SECTION 22 05 18 - ESCUTCHEONS FOR PLUMBING PIPING.
H. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in DIVISION 07.
I. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in SECTION 22 07 19 - PLUMBING PIPING INSULATION.

3.03 CONNECTIONS:

A. Connect sinks with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
B. Comply with water piping requirements specified in SECTION 22 11 16 - DOMESTIC WATER PIPING.
C. Comply with soil and waste piping requirements specified in SECTION 22 13 16 - SANITARY WASTE AND VENT PIPING.

3.04 ADJUSTING:

A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.
B. Adjust water pressure at faucets to produce proper flow.
C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.05 CLEANING AND PROTECTION:

A. After completing installation of sinks, inspect and repair damaged finishes.
B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
C. Provide protective covering for installed sinks and fittings.
D. Do not allow use of sinks for temporary facilities, unless approved in writing by Owner.

END OF SECTION 22 42 16.16

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SECTION 22 45 00 – EMERGENCY 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.

1.02 SUMMARY:

A. This SECTION includes:
   1. Eyewash equipment.
   2. Water-tempering equipment.

1.03 REFERENCES:

A. Applicable Standards (Latest Edition):
   1. American National Standards Institute (ANSI):
      a. ANSI Z358.1 - Emergency Eyewash and Shower Equipment.
   2. American Society of Mechanical Engineers/Canadian Standards Association (ASME/CSA):
      a. ASME A112.18.2/CSA B125.2 - Plumbing Waste Fittings.
   3. Federal Government:
      a. Public Law 90-480 - Architectural Barriers Act.
      b. Public Law 101-336 - Americans with Disabilities Act.
   4. International Code Council/American National Standards Institute (ICC/ANSI):
      a. ICC/ANSI A117.1 - Accessible and Usable Buildings and Facilities.
   5. NFPA:
      a. NFPA 70 - National Electrical Code.
   6. NSF International (NSF):
      a. NSF 61 - Drinking Water System Components - Health Effects.

1.04 DEFINITIONS:

A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.
B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.
C. Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid-solution supply.
D. Tepid: Moderately warm.

1.05 ACTION SUBMITTALS:

A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.
B. Shop Drawings: Diagram power, signal, and control wiring.

1.06 INFORMATIONAL SUBMITTALS:

A. Field quality-control test reports.

1.07 CLOSEOUT SUBMITTALS:

A. Operation and Maintenance Data: For emergency plumbing fixtures to include in operation and maintenance manuals.

1.08 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. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."
C. NSF Standard: Comply with NSF 61, "Drinking Water System Components - Health Effects," for fixture materials that will be in contact with potable water.
D. Regulatory Requirements: Comply with requirements in ICC/ANSI A117.1, "Accessible and Usable Buildings and Facilities" ; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

PART 2 - PRODUCTS

A. Sink, Swivel-Type, Plumbed Eyewash Unit, <SK-6>:
    1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        a. Acorn Safety; a division of Acorn Engineering Company.
        b. Bradley Corporation.
        c. Encon Safety Products.
        d. Guardian Equipment Co.
        e. Haws Corporation.
        f. Speakman Company.
        g. WaterSaver Faucet Co.
    2. Capacity: Not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.
    3. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
    4. Control-Valve Actuator: Movement of spray-head assembly to position over sink.
    5. Spray-Head Assembly: Two spray heads with offset piping.
    6. Mounting: Deck next to sink.
    7. Thermostatic Mixing Valve: Designed to provide 85ºF (29ºC) tepid, potable water at emergency plumbing fixtures, to maintain temperature at ±5ºF (3ºC) throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.
        a. Supply Connections: For hot and cold water.

2.02 SOURCE QUALITY CONTROL:

A. Certify performance of emergency plumbing fixtures by independent testing organization acceptable to authorities having jurisdiction.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 EMERGENCY PLUMBING FIXTURE INSTALLATION:

A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.
B. Install fixtures level and plumb.
C. Fasten fixtures to substrate.

D. Install shutoff valves in water-supply piping to fixtures. Use ball, gate, or globe valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Comply with requirements for valves specified in SECTION 22 05 23 - GENERAL-DUTY VALVES FOR PLUMBING PIPING.
   1. Exception: Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.

E. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals. Comply with requirements for dielectric fittings specified in SECTION 22 11 16 - DOMESTIC WATER PIPING.

F. Install thermometers in supply and outlet piping connections to water-tempering equipment. Comply with requirements for thermometers specified in SECTION 22 05 19 - METERS AND GAUGES FOR PLUMBING PIPING.

G. Install trap and waste piping on drain outlet of emergency equipment receptors that are indicated to be directly connected to drainage system. Comply with requirements for waste piping specified in DIVISION 22, SECTION "SANITARY WASTE AND VENT PIPING."

3.03 CONNECTIONS:

A. Connect cold-water-supply piping to plumbed emergency plumbing fixtures not having water-tempering equipment. Comply with requirements for cold-water piping specified in DIVISION 22, SECTION "DOMESTIC WATER PIPING."

B. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in DIVISION 22, SECTION "DOMESTIC WATER PIPING."

C. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary waste and vent piping. Comply with requirements for waste piping specified in DIVISION 22, SECTION "SANITARY WASTE AND VENT PIPING."

D. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.04 IDENTIFICATION:

A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment. Comply with requirements for identification materials specified in SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT.

3.05 FIELD QUALITY CONTROL:

A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.

B. Tests and Inspections:
   1. Perform each visual and mechanical inspection.
   2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Emergency plumbing fixtures and water-tempering equipment will be considered defective if they do not pass tests and inspections.
D. Prepare test and inspection reports.

3.06 ADJUSTING:

A. Adjust or replace fixture flow regulators for proper flow.
B. Adjust equipment temperature settings.

END OF SECTION 22 45 00

SECTION 22 61 13 – COMPRESSED-AIR PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 - GENERAL

1.01 SUMMARY:

A. This SECTION includes:
   1. Medical air piping and specialties, designated "Medical Air," operating at 50 to 55 psig (345 to 380 kPa).

B. Related Work Specified Elsewhere:
   1. SECTION 22 61 19 - COMPRESSED-AIR EQUIPMENT for Laboratory and Healthcare Facilities.
   2. Specification 07 84 13 – Penetration Firestopping.

1.02 REFERENCES:

A. Applicable Standards:
   1. American Society of Sanitary Engineering (ASSE):
      a. 6010 - Medical Gas Installers.
      b. 6020 - Medical Gas Systems Inspectors.
      c. 6030 - Medical Gas Systems Verifiers.
   2. American Welding Society (AWS):
      a. A5.8/A5.8M - Filler Metals for Brazing and Braze Welding.
      b. B2.2 - Brazing Procedure and Performance Qualification.
   3. ASME International (ASME):
      a. B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
      b. B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
      c. B31.1 - Power Piping.
      d. B31.9 - Building Services Piping.
      e. 2004 ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   4. ASTM International (ASTM):
      a. B32 - Solder Metal.
      b. B88 - Seamless Copper Water Tube.
      c. B88M - Seamless Copper Water Tube [Metric].
      d. B813 - Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube and Fittings.
      e. B819 - Seamless Copper Tube for Medical Gas Systems.
      f. B828 - Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.
      g. C1107 - Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
      h. D1785 - Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
      i. D2466 - Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
      j. D2564 - Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
      k. D2672 - Joints for IPS PVC Pipe Using Solvent Cement.
      l. F402 - Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings.
      m. F656 - Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
      n. F2063 - Wrought Nickel-Titanium Shape Memory Alloys for Medical Device and Surgical Implants.

5. Compressed Gas Association (CGA):
   a. G-4.1 - Cleaning Equipment for Oxygen Service.
   b. V-1 - Compressed Gas Cylinder Valve Outlet and Inlet Connections.
   c. V-5 - Diameter-Index Safety System (Noninterchangeable) Low Pressure Connections for Medical Gas Applications.
6. Copper Development Association Inc. (CDA):
   a. Copper Tube Handbook.
7. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):
   a. SP-73 - Brazing Joints for Copper and Copper Alloy Pressure Fittings.
   b. SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
   c. SP-123 - Non-Ferrous Threaded and Solder-Joint Unions for Use with Copper Water Tube.
8. National Association of Architectural Metal Manufacturers (NAAMM AMP):
   a. 503 - Finishes for Stainless Steel.
9. National Fire Protection Association (NFPA):
   a. 70 - National Electrical Code.
   b. 99 - Health Care Facilities.
10. U.S. Pharmacopeia (12601 Twinbrook Pkwy, Rockville, MD 20852; 800-822-8772; 301-881-0666) (USP):
    a. 28 - NF 23.

1.03 DEFINITIONS:

A. D.I.S.S.: Diameter-index safety system.
B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50V or for remote-control, signaling power-limited circuits.
C. Medical Compressed-Air Piping Systems: Include Medical Air (MA) piping systems.

1.04 SUBMITTALS:

A. Product Data: For the following:
   1. Compressed-air tubes and fittings.
   2. Compressed-air valves and valve boxes.
   3. Medical compressed-air service connections.
   4. Medical compressed-air alarm system components.
B. Shop Drawings: Diagram power, signal, and control wiring.
C. Piping Material Certification: Signed by Installer certifying that medical compressed-air piping materials comply with NFPA 99 requirements.
D. Qualification Data: For Installer and testing agency.
E. Brazing certificates.
F. Field quality-control test reports.
G. Operation and Maintenance Data: For compressed-air piping specialties to include in emergency, operation, and maintenance manuals.

1.05 QUALITY ASSURANCE:

A. Installer Qualifications:
   1. Medical Compressed-Air Piping Systems for Healthcare Facilities: Qualify installers according to ASSE 6010.

2. Pressure-Seal Joining Procedure for Copper Tubing: Qualify operators according to training provided by Viega; Plumbing and Heating Systems.

B. Testing Agency Qualifications: An independent nationally recognized testing agency, with the experience and capability to conduct the medical air piping testing indicated, that is an NRTL, and that is acceptable to authorities having jurisdiction.
1. Qualify testing personnel according to ASSE 6020 for inspectors and ASSE 6030 for verifiers.

C. Source Limitations: Obtain compressed-air service connections of same type and from same manufacturer as service connections provided for in SECTION 22 63 13 - GAS PIPING FOR LABORATORY AND HEALTHCARE FACILITIES.

D. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code, or AWS B2.2.

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. Comply with NFPA 99 for medical compressed-air system materials and installation in healthcare facilities.

1.06 COORDINATION:

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in DIVISION 03.

B. Coordinate medical compressed-air service connections with other service connections. Medical vacuum service connections are specified in SECTION 22 62 13 - VACUUM PIPING FOR LABORATORY AND HEALTHCARE FACILITIES and medical gas service connections are specified in SECTION 22 63 13 - GAS PIPING FOR LABORATORY AND HEALTHCARE FACILITIES.

1.07 EXTRA MATERIALS:

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Quick-Coupler Service Connections: Furnish complete noninterchangeable medical compressed-air pressure outlets.
a. Medical Compressed-Air Service Connections: Equal to 5% of amount installed, but no fewer than 5 units.
2. Medstar/Oxequip Connections: Furnish complete noninterchangeable medical compressed-air pressure outlets complying with CGA V-5.
a. Compressed-Air: Equal to 5% of amount installed, but no fewer than 5 units.

PART 2 - PRODUCTS

2.01 PIPES, TUBES, AND FITTINGS:

A. Copper Medical Gas Tube: ASTM B819, 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 for Type L tube.
1. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.

2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.
3. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.
4. Press-Type Fittings:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      (1) Viega; Plumbing and Heating Systems.
      (2) <Insert manufacturer's name>.
   b. NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
   c. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.

B. Memory-Metal Couplings: Cryogenic compression fitting made of ASTM F2063, nickel-titanium, shape-memory alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Smart Technology, Inc.

C. Copper Water Tube: ASTM B88, Type M (ASTM B88M, Type C), seamless, drawn temper.
1. Copper Fittings: ASME B16.18, cast-copper or ASME B16.22, wrought-copper, solder-joint pressure type.

2.02 JOINING MATERIALS:

A. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.

B. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

C. Threaded-Joint Tape: PTFE.

2.03 VALVES:

A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.

B. Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Allied Healthcare Products, Inc.; Chemetron Div.
   b. Amico Corporation.
   c. BeaconMedaes.
2. Pressure Rating: 300 psig (2070 kPa) minimum.
3. Ball: Full-port, chrome-plated brass.
4. Seats: PTFE or TFE.
5. Handle: Lever type with locking device.
6. Stem: Blowout proof with PTFE or TFE seal.
7. Ends: Manufacturer-installed ASTM B819, copper-tube extensions.

C. Ball Valves: MSS SP-72, split body, stainless steel.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Allied Healthcare Products, Inc.; Chemetron Div.

2. Pressure Rating: 300 psig (2070 kPa) minimum.
3. Ball: Full-port, stainless steel.
4. Seats: PTFE or TFE.
5. Handle: Lever type with locking device.
6. Stem: Blowout proof with PTFE or TFE seal.
7. Ends: Flanged.

D. Check Valves: In-line pattern, bronze.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Allied Healthcare Products, Inc.; Chemetron Div.
b. Amico Corporation.
c. BeaconMedaes.
2. Pressure Rating: 300 psig (2070 kPa) minimum.
3. Operation: Spring loaded.
4. Ends: Manufacturer-installed ASTM B819, copper-tube extensions.

E. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gauge.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Allied Healthcare Products, Inc.; Chemetron Div.
b. Amico Corporation.
c. BeaconMedaes.
2. Pressure Rating: 300 psig (2070 kPa) minimum.
3. Ball: Full-port, chrome-plated brass.
4. Seats: PTFE or TFE.
5. Handle: Lever type with locking device.
6. Stem: Blowout proof with PTFE or TFE seal.
7. Ends: Manufacturer-installed ASTM B819, copper-tube extensions.
8. Pressure Gauge: Manufacturer installed on one copper-tube extension.

F. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gauges and in sizes required to permit manual operation of valves.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Allied Healthcare Products, Inc.; Chemetron Div.
b. Amico Corporation.
c. BeaconMedaes.
2. Interior Finish: Factory-applied white enamel.
3. Cover Plate: Aluminum or extruded-anodized aluminum with frangible or removable windows.
4. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

G. Safety Valves: Bronze-body, ASME-construction, poppet, pressure-relief type with settings to match system requirements.

H. Pressure Regulators: Bronze body and trim; spring-loaded, diaphragm-operated relieving type; manual pressure-setting adjustment; rated for 250-psig (1725-kPa) minimum inlet pressure;

and capable of controlling delivered air pressure within 0.5 psig for each 10-psig (5.0 kPa for each 100-kPa) inlet pressure.

I. Automatic Drain Valves: Stainless-steel body and internal parts, rated for 200-psig (1380-kPa) minimum working pressure, capable of automatic discharge of collected condensate.

2.04 MEDICAL COMPRESSED-AIR SERVICE CONNECTIONS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Allied Healthcare Products, Inc.; Chemetron Div. (Medstar/Oxequip)

B. Connection Devices: For specific medical compressed-air pressure and service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.
   1. Roughing-in Assembly:
      a. Steel outlet box for recessed mounting and concealed piping.
      b. Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed.
      c. Double seals that will prevent air leakage.
      d. ASTM B819, NPS 3/8 (DN 10) copper outlet tube brazed to valve with service marking and tube-end dust cap.
   2. Finishing Assembly:
      a. Brass housing with primary check valve.
      b. Double seals that will prevent air leakage.
      c. Cover plate with gas-service label.
   3. Quick-Coupler Service Connections: Pressure outlet with noninterchangeable 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.
   4. Medstar/Oxequip Service Connections: Pressure outlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.
      a. Medical Air Service Connections: CGA V-5, Medstar/Oxequip.
   5. Cover Plates: One piece, stainless steel, with NAAMM AMP 503, No. 4 finish and permanent, color-coded, identifying label matching corresponding service.

2.05 MEDICAL COMPRESSED-AIR PIPING ALARM SYSTEMS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Allied Healthcare Products, Inc.; Chemetron Div. (Oxequip)

B. Panels for medical compressed-air piping systems may be combined in single panels with medical vacuum and medical gas piping systems.

C. Components: Designed for continuous service and to operate on power supplied from 120Vac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.

D. Dew Point Monitors: Continuous line monitoring, having panel with gauge or digital display, pipeline sensing element, electrical connections for alarm system, factory- or field-installed

valved bypass, and visual and cancelable audio signal for dryer site and master alarm panels. Alarm signals when pressure dew point rises above 39ºF (4ºC) at 55 psig (380 kPa).

1. Operation: Chilled-mirror method or hygrometer moisture analyzer with sensor probe.

E. Pressure Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
   1. Low-Pressure Operating Range: 0 to 100 psig (0 to 690 kPa).
   2. High-Pressure Operating Range: Up to 250 psig (1725 kPa).

F. Carbon Monoxide Monitors: Panel with gauge or digital display, pipeline sensing element, electrical connections for alarm system, and factory- or field-installed valved bypass. Alarm signals when carbon monoxide level rises above 10 ppm.

G. General Requirements for Medical Compressed-Air Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
   1. Mounting: Recessed installation.
   2. Enclosures: Fabricated from minimum 0.047-inch (1.2-mm) thick steel or minimum 0.05-inch (1.27-mm) thick aluminum, with knockouts for electrical and piping connections.

H. Area Alarm Panels: Separate trouble alarm signals, pressure gauges, and indicators for medical compressed-air piping systems.
   1. Include alarm signals when the following condition exists:
      a. Medical Air: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).

2.06 FLEXIBLE PIPE CONNECTORS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Flex-Hose Co., Inc.
   2. Flexicraft Industries.
   3. Hyspan Precision Products, Inc.
   4. Metraflex, Inc.
   5. Universal Metal Hose; a Hyspan Co.

B. Description: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
   1. Working-Pressure Rating: 250 psig (1725 kPa) minimum.
   2. End Connections: Threaded copper pipe or plain-end copper tube.

2.07 SLEEVES:

A. See SECTION 22 05 17 – SLEEVES AND SEALS FOR PLUMBING PIPING.

2.08 ESCUTCHEONS:

A. See SECTION 22 05 18 – ESCUTCHEONS FOR PLUMBING PIPING.

2.09 GROUT:

A. Description: ASTM C1107, 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: 5,000-psi (34.5-MPa), 28-day compressive strength.

3. Packaging: Premixed and factory packaged.

2.10 NITROGEN:

A. Description: Comply with USP 28 - NF 23 for oil-free dry nitrogen.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are 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, gauges, 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 APPLICATIONS:

A. Connect new tubing to existing tubing with memory-metal couplings.
B. Medical Air Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
C. Drain Piping: Use the following piping materials:
   1. Copper water tube, press-type fittings, and pressure-sealed joints.

3.03 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 ASSE 6010 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 air and drain piping with 1% 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 below 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 gauge on discharge piping from each air compressor and on each receiver. Comply with requirements in SECTION 22 05 19 – 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 branch connections.
O. Install medical compressed-air piping to medical compressed-air service connections specified in this SECTION, to medical compressed-air service connections in equipment specified in SECTION 22 63 13 - GAS PIPING FOR LABORATORY AND HEALTHCARE FACILITIES and to equipment specified in other sections requiring medical compressed-air service.
P. Install seismic restraints on compressed-air piping. Seismic-restraint devices are specified in SECTION 22 05 48 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT.
Q. Install firestopping systems for piping penetration of rated walls, ceiling, and floor. Comply with requirements for firestopping specified in SECTION 07 84 13 – PENETRATION FIRESTOPPING.
R. Install compressed-air service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
S. Connect compressed-air piping to air compressors and to compressed-air outlets and equipment requiring compressed-air service.
T. Install unions in copper compressed-air tubing adjacent to each valve and at final connection to each piece of equipment, machine, and specialty.

3.04 VALVE APPLICATIONS:
A. Valves for Copper Air Tubing: Use copper alloy ball and bronze check types.

3.05 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 gauges in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.
E. Install safety valves on compressed-air receivers where required by NFPA 99 and where recommended by specialty manufacturers.
F. Install pressure regulators on compressed-air piping where reduced pressure is required.
G. Install automatic drain valves on equipment, specialties, and piping with drain connection. Run drain piping to floor drain so contents spill over or into it.
H. Install flexible pipe connectors in discharge piping and in inlet air piping from remote air-inlet filter of each air compressor.

3.06 JOINT CONSTRUCTION:

A. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
B. Threaded Joints: Apply appropriate tape to external pipe threads.
C. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free dry nitrogen during brazing.
D. Soldered Joints: Apply ASTM B813, water-flushable flux to tube end. Join copper tube and fittings according to ASTM B828.
E. Pressure-Sealed Joints: Join copper tube and press-type fittings with tools recommended by fitting manufacturer.
F. Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of memory-metal coupling joints.

3.07 MEDICAL COMPRESSED-AIR-PIPING ALARM SYSTEM INSTALLATION:

A. Alarm panels for medical compressed-air piping systems may be combined in single panels with medical vacuum piping systems and medical gas piping systems.
B. Install alarm system components for medical compressed-air-piping according to and in locations required by NFPA 99.
C. Install area and master alarm panels for medical compressed-air piping system where indicated.

3.08 SLEEVE INSTALLATION:

A. Sleeves are not required for core-drilled holes.
B. Permanent sleeves are not required for holes formed by removable PE sleeves.
C. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs using galvanized-steel pipe.
    1. Wall Penetrations: Cut sleeves to length for mounting flush with both surfaces.
    2. Floor Penetrations: 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.
D. Install sleeves in new walls and slabs as new walls and slabs are constructed.
E. Install sleeves that are large enough to provide 1/4-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 NPS 6 (DN 150.
    2. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger penetrating gypsum board partitions.
    3. 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. Comply with requirements in DIVISION 07 for flashing.
        a. Seal space outside of sleeve fittings with grout.
F. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in DIVISION 07.

3.09 ESCUTCHEON INSTALLATION:

A. Install escutcheons for penetrations of walls, ceilings, and floors per SECTION 22 05 18 - ESCUTCHEONS FOR PLUMBING PIPING.

3.10 HANGER AND SUPPORT INSTALLATION:

A. Comply with requirements in SECTION 22 05 48 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT for seismic-restraint devices.
B. Comply with requirements in SECTION 22 05 29 - HANGERS AND SUPPORTS for pipe hanger and support devices.
C. Vertical Piping: MSS Type 8 or 42, clamps.
D. Individual, Straight, Horizontal Piping Runs:
   1. MSS Type 1, adjustable, steel, clevis hangers.
E. Base of Vertical Piping: MSS Type 52, spring hangers.
F. Support horizontal piping within 12 inches (300 mm) of each fitting and coupling.
G. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.
H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1/4 (DN 8): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
   2. NPS 3/8 and NPS 1/2 (DN 10 and DN 15): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
   3. NPS 3/4 (DN 20): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
   4. NPS 1 (DN 25): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
   5. NPS 1-1/4 (DN 32): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
   6. NPS 1-1/2 (DN 40): 10 feet (3 m) with 3/8-inch (10-mm) rod.
   7. NPS 2 (DN 50): 11 feet (3.4 m) with 3/8-inch (10-mm) rod.
   8. NPS 2-1/2 (DN 65): 13 feet (4 m) with 1/2-inch (13-mm) rod.
   9. NPS 3 (DN 80): 14 feet (4.3 m) with 1/2-inch (13-mm) rod.
   10. NPS 3-1/2 (DN 90): 15 feet (4.6 m) with 1/2-inch (13-mm) rod.
   11. NPS 4 (DN 100): 16 feet (4.9 m) with 1/2-inch (13-mm) rod.
   12. NPS 5 (DN 125): 18 feet (5.5 m) with 1/2-inch (13-mm) rod.
   13. NPS 6 (DN 150): 20 feet (6 m) with 5/8-inch (16-mm) rod.
   14. NPS 8 (DN 200): 23 feet (7 m) with 3/4-inch (19-mm) rod.
I. Install supports for vertical copper tubing every 10 feet (3 m).

3.11 LABELING AND IDENTIFICATION:

A. 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.

3.12 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 prepare test reports.
   1. Also engage commissioning agent to witness testing.
B. Perform tests and inspections of medical compressed-air piping systems in healthcare facilities and prepare test reports.
C. 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 vacuum piping and medical gas piping systems.
2. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE 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: Comply with requirements in NFPA 99, ASSE 6020, and ASSE 6030 for verification of medical compressed-air piping systems and perform the following tests and inspections:
   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.

D. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.13 DEMONSTRATION:

A. Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain medical compressed-air alarm systems. Refer to DIVISION 01.

END OF SECTION 22 61 13

SECTION 22 62 13 - VACUUM PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 - GENERAL

1.01 SUMMARY:

A. This SECTION includes the following:
   1. Medical surgical vacuum piping and specialties, designated "medical vacuum" operating at 20 inches mercury (510 mm mercury or 67.7 kPa vacuum).
   2. Waste anesthetic gas disposal piping and specialties, designated "WAGD" operating at 20 inches mercury (510mm mercury or 50.7 kPa vacuum).

B. Related Work Specified Elsewhere:
   1. SECTION 22 62 19 - VACUUM EQUIPMENT FOR LABORATORY AND HEALTHCARE FACILITIES.
   2. Specification 07 84 13 – Penetration Firestopping.

1.02 REFERENCES:

A. Applicable Standards:
   1. American Society of Sanitary Engineering (ASSE):
      a. 6010 - Medical Gas Systems Installers.
      b. 6020 - Medical Gas Systems Inspectors.
      c. 6030 - Medical Gas Systems Verifiers.
   2. American Welding Society (AWS):
      a. A5.8/A5.8M - filler Metals for Brazing and Braze Welding.
      b. B2.2 - Brazing Procedure and Performance Qualification.
   3. ASME International (ASME):
      a. B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
      b. B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.
      c. B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
      d. B16.24 - Cast Copper Alloy Pipe Flanges, Class 150, 300, 400, 600, 900, 1500, and 2500, and Flanged Fittings, Class 150 and 300.
      e. B18.2.1 - Square and Hex Bolts and Screws, Inch Series.
      f. B31.9 - Building Services Piping.
      g. 2004 ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   4. ASTM International (ASTM):
      a. B32 - Solder Metal.
      b. B88 - Seamless Copper Water Tube.
      c. B88M - Seamless Copper Water Tube (Metric).
      d. B813 - Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube and Fittings.
      e. B819 - Seamless Copper Tube for Medical Gas Systems.
      f. B828 - Practice for Making Capillary Joints by soldering of Copper and Copper Alloy Tube and Fittings.
      g. C1107 - Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
      h. D1785 - Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
      i. D2466 - Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
      j. D2467 - Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
      k. D2564 - Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
      l. D2672 - Joints for IPS PVC Pipe Using Solvent Cement.

m. F402 - Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings.
n. F656 - Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
o. F2063 - Wrought Nickel-Titanium Shape Memory Alloys for Medical Devices and Surgical Implants.

5. Compressed Gas Association (CGA):
   a. G-4.1 - Cleaning Equipment for Oxygen Service.
   b. V-5 - Diameter-Index Safety System (Noninterchangeable) Low Pressure Connections for Medical Gas Applications.
6. Copper Development Association Inc. (CDA):
   a. Copper Tube Handbook.
7. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):
   a. SP-73 - Brazing Joints for Copper and Copper Alloy Pressure Fittings.
   b. SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
   c. SP-122 - Plastic Industrial Ball Valves.
   d. SP-123 - Non-Ferrous Threaded and Solder-Joint Unions for Use with Copper Water Tube.
8. National Association of Architectural Metal Manufacturers (NAAMM AMP):
   a. 503 - Finishes for Stainless Steel.
9. National Fire Protection Association (NFPA):
   a. 70 - National Electrical Code.
   b. 99 - Health Care Facilities.
10. U.S. Pharmacopeia (12601 Twinbrook Parkway, Rockville, MD 20852; 800-822-8772; 301-881-0666) (USP):
    a. USP 28 - NF 23.

1.03 DEFINITIONS:

A. D.I.S.S.: Diameter-index safety system.
B. HVE: High-volume (oral) evacuation.
C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
D. WAGD: Waste anesthetic gas disposal.
E. Medical vacuum piping systems include medical vacuum and WAGD piping systems.

1.04 SUBMITTALS:

A. Product Data: For the following:
   1. Vacuum pipes and fittings.
   2. Vacuum valves and valve boxes.
B. Shop Drawings: Diagram power, signal, and control wiring.
C. Piping Material Certification: Signed by Installer certifying that medical vacuum piping materials comply with NFPA 99 requirements.
D. Qualification Data: For Installer and testing agency.
E. Brazing certificates.
F. Field quality-control test reports.

G. Operation and Maintenance Data: For vacuum piping specialties to include in emergency, operation, and maintenance manuals.

1.05 QUALITY ASSURANCE:

A. Installer Qualifications:
   1. Medical Vacuum Piping Systems for Healthcare Facilities: Qualify installers according to ASSE 6010.
   2. Pressure-Seal Joining Procedure for Copper Tubing: Qualify operators according to training provided by Viega; Plumbing and Heating Systems.

B. Testing Agency Qualifications: An independent nationally-recognized testing agency, with the experience and capability to conduct the vacuum piping testing indicated, that is an NRTL, and that is acceptable to authorities having jurisdiction.
   1. Qualify testing personnel according to ASSE 6020 for inspectors and ASSE 6030 for verifiers.

C. Source Limitations: Obtain vacuum service connections of samy type from same manufacture as service connections provided for in SECTION 22 63 13 – GAS PIPING FOR LABORATORY AND HEALTHCARE FACILITIES.

D. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code or AWS B2.2.

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. Comply with ASME B31.9 for vacuum piping in laboratory facilities.

G. NFPA Compliance: Comply with NFPA 99 for medical vacuum system materials and installation in healthcare facilities.

1.06 COORDINATION:

A. Coordinate medical vacuum service connections with other service connections. Medical compressed-air service connections are specified in SECTION 22 61 13 - COMPRESSED-AIR PIPING FOR LABORATORY AND HEALTHCARE FACILITIES, and medical gas service connections are specified in SECTION 22 63 13 - GAS PIPING FOR LABORATORY AND HEALTHCARE FACILITIES.

1.07 EXTRA MATERIALS:

A. Furnish extra materials descrived below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Quick-Coupler Service Connections: Furnish complete noninterchangeable medical compressed-air pressure outlets.
      a. Medical Vacuum Service Connections: Equal to 5% of amount installed, but no fewer than 5 units.
   2. Medstar/Oxequip Connections: Furnish complete noninterchangeable medical vacuum outlets complying with CGA V-5.
      a. Vacuum: Equal to 5% of amount installed, but no fewer than 5 units.

PART 2 - PRODUCTS

2.01 PIPES, TUBES, AND FITTINGS:

A. Copper Medical Gas Tube: ASTM B819, Type L, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service. Include standard color marking "MED VAC" in blue.
   1. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged.
   2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.
   3. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.

B. Memory-Metal Couplings: Cryogenic compression fitting made of ASTM F2063, nickel-titanium, shape-memory alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Smart Technology, Inc.

C. Copper Water Tube: ASTM B88, Type M (ASTM B88M, Type C), seamless, drawn temper.
   1. Copper Fittings: ASME B16.18, cast-copper or ASME B16.22, wrought-copper, solder-joint pressure type.
   2. Press-Type Fittings:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         (1) Viega; Plumbing and Heating Systems.
         (2) Engineer approved equal.
      b. NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
      c. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.

2.02 JOINING MATERIALS:

A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

B. Threaded-Joint Tape: PTFE.

C. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness, full-face type.

D. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.

2.03 VALVES:

A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.

B. Copper-Alloy Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Health Products, Chemetron Div.
      b. Amico Corporation.
      c. BeaconMedaes.
   2. Pressure Rating: 300 psig (2070 kPa) minimum.
   3. Ball: Full-port, chrome-plated brass.
   4. Seats: PTFE or TFE.
   5. Handle: Lever type with locking device.

6. Stem: Blowout proof with PTFE or TFE seal.
7. Ends: Manufacturer-installed ASTM B819, copper-tube extensions.

C. Bronze Check Valves: In-line pattern.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Allied Health Products, Chemetron division
b. Amico Corporation.
c. BeaconMedaes.
2. Pressure Rating: 300 psig (2070 kPa) minimum.
3. Operation: Spring loaded.
4. Ends: Manufacturer-installed ASTM B819, copper-tube extensions.

D. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gauge.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Allied Health Products, Chemetron Division
b. Amico Corporation.
c. BeaconMedaes.
2. Pressure Rating: 300 psig (2070 kPa) minimum.
3. Ball: Full-port, chrome-plated brass.
4. Seats: PTFE or TFE.
5. Handle: Lever type with locking device.
6. Stem: Blowout proof with PTFE or TFE seal.
7. Ends: Manufacturer-installed ASTM B819, copper-tube extensions.
8. Vacuum Gauge: Manufacturer installed on one copper-tube extension.

E. Safety Valves: Bronze-body, ASME-construction, pressure-relief type with settings to match system requirements.

F. Automatic Drain Valves: Stainless-steel body and internal parts, rated for 200-psig (1380-kPa) minimum working pressure, capable of automatic discharge of collected condensate.

2.04 MEDICAL VACUUM SERVICE CONNECTIONS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Allied Health Products, Chemetron Division (Medstar/Oxequip)

B. Connection Devices: For specific medical vacuum service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.
1. Roughing-in Assembly:
a. Steel outlet box for recessed mounting and concealed piping.
b. Brass-body inlet block.
c. Seals that will prevent vacuum leakage.
d. ASTM B819, NPS 3/8 (DN 10) copper outlet tube brazed to valve with service marking and tube-end dust cap.
2. Finishing Assembly:
a. Brass housing with primary check valve.
b. Seals that will prevent vacuum leakage.
c. Cover plate with gas-service label.

3. Medstar/Oxequip Service Connections: Suction inlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.
   a. Medical Vacuum Service Connections: CGA V-5, Medstar/Oxequip.
   b. WAGD Evacuation Service Connections: CGA V-5, Medstar/Oxequip.
4. Cover Plates: One piece, stainless steel, with NAAMM AMP 503, No. 4 finish and permanent, color-coded, identifying label matching corresponding service.

2.05 MEDICAL VACUUM PIPING ALARM SYSTEMS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Allied Healthcare Products, Inc.; Chemetron Div. (Oxequip)
B. Panels for medical vacuum piping systems may be combined in single panels with medical compressed air and medical gas piping systems.
C. Components: Designed for continuous service and to operate on power supplied from 120Vac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.
D. Vacuum Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
   1. Vacuum Operating Range: 0 to 30-in. Hg. (0 to 101 kPa vacuum).
E. General Requirements for Medical Vacuum Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
   1. Mounting: Recessed installation.
   2. Enclosures: Fabricated from minimum 0.047-inch (1.2-mm) thick steel or minimum 0.05-inch (1.27-mm) thick aluminum, with knockouts for electrical and piping connections.
F. Area Alarm Panels: Separate trouble alarm signals, pressure gauges, and indicators for medical compressed-air piping systems.
   1. Include alarm signals when the following condition exists:
      a. Medical Vacuum: Pressure drops below 12-in.Hg. (40 kPa vacuum).

2.06 FLEXIBLE PIPE CONNECTORS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Flex-Hose Co., Inc.
   2. Flexicraft Industries.
   3. Hyspan Precision Products, Inc.
   4. Mercer Rubber Co.
   5. Metraflex, Inc.
   6. Unaflex.
   7. Universal Metal Hose; a Hyspan Co.
B. Description: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
   1. Working-Pressure Rating: 200 psig (1380 kPa) minimum.
   2. End Connections: Threaded copper pipe or plain-end copper tube.

2.07 SLEEVES:
A. See SECTION 22 05 17 – SLEEVES AND SEALS FOR PLUMBING PIPING.

2.08 ESCUTCHEONS:
A. See SECTION 22 05 18 – ESCUTCHEONS FOR PLUMBING PIPING.

2.09 GROUT:
A. Description: ASTM C1107, 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 (34.5-MPa), 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.10 NITROGEN:
A. Description: Comply with USP 28 - NF 23 for oil-free dry nitrogen.

PART 3 - EXECUTION

3.01 PREPARATION:
A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are 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, gauges, 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 APPLICATIONS:
A. Connect new copper tubing to existing tubing with memory-metal couplings.
B. Medical Vacuum Piping: Use the following piping materials for each size range:
1. NPS 4 (DN 100) and Smaller: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
C. WAGD Piping: Use the following piping materials for each size range:
1. NPS 4 (DN 100) and Smaller: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
D. Drain Piping: Use the following piping materials:
1. Copper water tube, press-type fittings, and pressure-sealed joints.

3.03 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, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Comply with ASSE 6010 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 and drain piping with 1 percent slope downward in direction of flow.
H. Install nipples, unions, and special fittings, and valves with pressure ratings same as or higher than piping pressure rating used in applications below 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 gauge on inlet piping to each vacuum producer and on each receiver. Comply with requirements in SECTION 22 05 19 - METERS AND GAUGES 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 vacuum piping to medical vacuum service connections specified in this SECTION and to equipment specified in other Sections requiring medical vacuum service.
P. Install seismic restraints on vacuum piping. Seismic-restraint devices are specified in SECTION 22 05 48 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT.
Q. Install firestopping systems for piping penetration of rated walls, ceiling, and floor. Comply with requirements for firestopping specified in SECTION 07 84 13 – PENETRATION FIRESTOPPING.
R. Install medical vacuum service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
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 piece of equipment, machine, and specialty.

3.04 VALVE APPLICATIONS:

A. Valves for Copper Vacuum Tubing: Use copper alloy ball and bronze check types.

3.05 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 gauges in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.
E. Install safety valves on vacuum receivers, where required by NFPA 99, and where recommended by specialty manufacturers.
F. Install automatic drain valves on equipment, specialties, and piping with drain connection. Run drain piping to floor drain, so contents spill over or into it.
G. Install flexible pipe connectors in suction inlet piping to each vacuum producer.

3.06 JOINT CONSTRUCTION:
A. Ream ends of pipes and tubes and remove burrs.
B. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
D. Threaded Joints: Apply appropriate tape to external pipe threads.
E. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. 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.
G. Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of memory-metal coupling joints.

3.07 SLEEVE INSTALLATION:
A. Sleeves are not required for core-drilled holes.
B. Permanent sleeves are not required for holes formed by removable PE sleeves.
C. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs using galvanized-steel pipe.
1. Wall Penetrations: Cut sleeves to length for mounting flush with both surfaces.
2. Floor Penetrations: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level.
D. Install sleeves in new walls and slabs as new walls and slabs are constructed.
E. Install sleeves that are large enough to provide 1/4-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 NPS 6 (DN 150).
F. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in DIVISION 07.

3.08 ESCUTCHEON INSTALLATION:
A. Install escutcheons for penetrations of walls, ceilings, and floors per SECTION 22 05 18 – ESCUTCHEONS FOR PLUMBING PIPING.

3.09 HANGER AND SUPPORT INSTALLATION:
A. Comply with requirements in SECTION 22 05 48 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT for seismic-restraint devices.

B. Comply with requirements in SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT for pipe hanger and support devices.
C. Vertical Piping: MSS Type 8 or 42, clamps.
D. Individual, Straight, Horizontal Piping Runs:
   1. MSS Type 1, adjustable, steel, clevis hangers.
E. Base of Vertical Piping: MSS Type 52, spring hangers.
F. Support horizontal piping within 12 inches (300 mm) of each fitting and coupling.
G. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.
H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 3/8 and NPS 1/2 (DN 10 and DN 15): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
   2. NPS 3/4 (DN 20): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
   3. NPS 1 (DN 25): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
   4. NPS 1-1/4 (DN 32): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
   5. NPS 1-1/2 (DN 40): 10 feet (3 m) with 3/8-inch (10-mm) rod.
   6. NPS 2 (DN 50): 11 feet (3.4 m) with 3/8-inch (10-mm) rod.
   7. NPS 2-1/2 (DN 65): 13 feet (4 m) with 1/2-inch (13-mm) rod.
   8. NPS 3 (DN 80): 14 feet (4.3 m) with 1/2-inch (13-mm) rod.
   9. NPS 3-1/2 (DN 90): 15 feet (4.6 m) with 1/2-inch (13-mm) rod.
   10. NPS 4 (DN 100): 16 feet (4.9 m) with 1/2-inch (13-mm) rod.
I. Install supports for vertical copper tubing every 10 feet (3 m).

3.10 LABELING AND IDENTIFICATION:

A. Install identifying labels and devices for laboratory vacuum piping, valves, and specialties. Comply with requirements in SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT.
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 purple background.

3.11 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 prepare test reports.
   a. Also engage commissioning agent to witness testing.
B. Perform tests and inspections of medical vacuum piping systems in healthcare facilities and prepare test reports.
C. 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. Perform the following Installer tests according to requirements in NFPA 99 and ASSE 6010:

a. Initial blow down.
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: Comply with requirements in NFPA 99, ASSE 6020, and ASSE 6030 for verification of medical vacuum piping systems and perform the following tests and inspections:
   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.

D. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.12 DEMONSTRATION:

A. Train Owner's maintenance personnel to adjust, operate, and maintain medical vacuum alarm systems. Refer to DIVISION 01.

END OF SECTION 22 62 13

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SECTION 22 63 13 – GAS PIPING FOR 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.

1.02 SUMMARY:

A. This SECTION includes the following:
   1. Carbon dioxide piping and specialties designated "Carbon Dioxide (CO2)" operating at 50 to 55 psig (345 to 380 kPa).
   2. Nitrogen piping and specialties designated "Nitrogen (N)" operating at 160 to 185 psig (1100 to 1275 kPa).
   3. Nitrous oxide piping and specialties designated "Nitrous Oxide (NO) " operating at 50 to 55 psig (345 to 380 kPa).
   4. Oxygen piping and specialties designated "Oxygen (O)" operating at 50 to 55 psig (345 to 380 kPa).

B. Owner-Furnished Material:
   1. Bulk gas storage tanks.
   2. Medical gas storage cylinders.
   3. Owner will furnish gases for medical gas concentration testing specified in this SECTION.

C. Related Work Specified Elsewhere:
   1. SECTION 22 61 13 - COMPRESSED-AIR PIPING FOR LABORATORY AND HEALTHCARE FACILITIES.
   2. SECTION 22 62 13 - VACUUM PIPING FOR LABORATORY AND HEALTHCARE FACILITIES.
   3. SECTION 07 84 13 – PENETRATION FIRESTOPPING.

1.03 REFERENCES:

A. Applicable Standards:
   1. American Society of Sanitary Engineering (ASSE):
      a. 6010 - Medical Gas Installers.
      b. 6020 - Medical Gas Inspectors.
      c. 6030 - Medical Gas Verifiers.
   2. American Welding Society (AWS):
      a. A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding.
      b. B2.2 - Standard for Brazing Procedure and Performance Qualification.
   3. ASME International (ASME):
      a. B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
      b. B31.9 - Building Services Piping.
      c. 2004 ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 01; Section IX, "Welding and Brazing Qualifications."
   4. ASTM International (ASTM):
      a. B819 - Seamless Copper Tube for Medical Gas Systems.
      b. C1107 - Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
      c. F2063 - Wrought Nickel-Titanium Shape Memory Alloys for Medical Devices and Surgical Implants.
   5. Code of Federal Regulations (CFR):

a. 29 CFR - Labor, Chapter XVII - Occupational Safety and Health Administration, Department of Labor, Part 1910 - "Occupational Safety and Health Standards," Subpart A - "General," Section 1910.7 - "Definition and Requirements for a Nationally Recognized Testing Laboratory."

6. Compressed Gas Association (CGA):
   a. G-4.1 - Cleaning Equipment for Oxygen Service.
   b. G-8.1 - Nitrous Oxide Systems at Consumer Sites.
   c. V-1 - Compressed Gas Cylinder Valve Outlet and Inlet Connections.
   d. V-5 - Diameter-Index Safety System (Noninterchangeable) Low Pressure Connections for Medical Gas Applications.
7. Copper Development Association Inc. (CDA):
   a. Copper Tube Handbook.
8. Manufacturers Standardization of the Valve and Fittings Industry, Inc. (MSS):
   a. SP-73 - Brazing Joints for Copper and Copper Alloy Pressure Fittings.
   b. SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
   c. SP-123 - Non-Ferrous Threaded and Solder-Joint Unions for Use with Copper Water Tube.
9. National Association of Architectural Metal Manufacturers (NAAMM AMP):
   a. 503 - Finishes for Stainless Steel.
10. National Electrical Manufacturers Association (NEMA):
    a. WD1 - General Requirements for Wiring Devices.
11. National Fire Protection Association (NFPA):
    a. 50 - Bulk Oxygen Systems at Consumer Sites.
    b. 70 - National Electrical Code.
    c. 99 - Health Care Facilities.
12. Structural Engineering Institute/American Society of Civil Engineers (SEI/ASCE):
    a. 7 - Minimum Design Loads for Buildings and Other Structures.
13. Underwriters Laboratories Inc. (UL):
    a. 498 - Attachment Plugs and Receptacles.
    b. 544 - Medical and Dental Equipment.
14. U.S. Pharmacopeia (12601 Twinbrook Parkway, Rockville, MD 20852; 800-822-8772; 301-881-0666) (USP):
    a. 28 - NF 23.

1.04 DEFINITIONS:

A. CR: Chlorosulfonated polyethylene synthetic rubber.
B. D.I.S.S.: Diameter-index safety system.
C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50V or for remote-control, signaling power-limited circuits.
D. Medical gas piping systems include carbon dioxide, nitrogen, nitrous oxide, and oxygen nonflammable gas for healthcare facility patient care or for healthcare laboratory applications.

1.05 PERFORMANCE REQUIREMENTS:

A. Seismic Performance: Gas manifolds and bulk gas storage tanks and piping shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.06 SUBMITTALS:

A. Product Data: For the following:
   1. Tubes and fittings.
   2. Valves and valve boxes.
   3. Medical gas service connections.
   4. Gas manifolds.
   5. Medical gas alarm system components.
   6. Gas cylinder storage racks.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Piping Material Certification: Signed by Installer certifying that medical gas piping materials comply with NFPA 99 requirements.

D. Qualification Data: For Installer and testing agency.

E. Brazing certificates.

F. Manufacturer Seismic Qualification Certification: Submit certification that gas manifolds and bulk gas storage tanks, accessories, and components will withstand seismic forces defined in SECTION 22 05 48 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT. Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

G. Certificates of Shop Inspection and Data Report for Bulk Gas Storage Tanks: As required by ASME Boiler and Pressure Vessel Code.

H. Field quality control test reports.

I. Operation and Maintenance Data: For medical gas piping specialties to include in emergency, operation, and maintenance manuals.

1.07 QUALITY ASSURANCE:

A. Installer Qualifications:
   1. Medical Gas Piping Systems for Healthcare Facilities: Qualify installers according to ASSE 6010 for installers.

B. Testing Agency Qualifications: An independent nationally recognized testing agency, with the experience and capability to conduct the medical gas piping testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   1. Qualify testing personnel according to ASSE 6020 for inspectors and ASSE 6030 for verifiers.

C. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code or AWS B2.2.

D. 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.

E. NFPA Compliance:
   1. Comply with NFPA 50 for bulk oxygen storage tanks.
   2. Comply with NFPA 99 for medical gas piping system materials and installation.

F. CGA Compliance: Comply with CGA G-8.1 for bulk nitrous oxide storage tanks.

G. UL Compliance:
1. Comply with UL 498 for electrical service connections.
2. Comply with UL 544 for medical gas specialties.

1.08 PROJECT CONDITIONS:

A. Interruption of Existing Medical Gas Service(s): Do not interrupt medical gas 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 Engineer, Construction Manager, and Owner no fewer than ten days in advance of proposed interruption of medical gas service(s).
2. Do not proceed with interruption of medical gas service(s) without Owner's written permission.

1.09 COORDINATION:

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in DIVISION 03.

B. Coordinate medical gas service connections with other service connections. Compressed-air service connections are specified in SECTION 22 61 13 - COMPRESSED-AIR PIPING FOR LABORATORY AND HEALTHCARE FACILITIES AND SECTION 22 62 13 - VACUUM PIPING FOR LABORATORY AND HEALTHCARE FACILITIES.

1.10 EXTRA MATERIALS:

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Quick-Coupler Service Connections: Furnish complete noninterchangeable medical gas pressure outlets and suction inlets.
a. Medical Air: Equal to 5% of amount installed, but no fewer than 5 units.
b. Oxygen: Equal to 5% of amount installed, but no fewer than 5 units.
c. Vacuum: Equal to 5% of amount installed, but no fewer than 5 units.
d. WAGD Evacuation: Equal to 5% of amount installed, but no fewer than 5 units.
2. Medstar/Oxequip Service Connections: Furnish complete noninterchangeable medical gas pressure outlets and suction inlets complying with CGA V-5.
a. Medical Air: Equal to 5% of amount installed, but no fewer than 5 units.
b. Oxygen: Equal to 5% of amount installed, but no fewer than 5 units.
c. Vacuum: Equal to 5% of amount installed, but no fewer than 5 units.
d. WAGD Evacuation: Equal to 5% of amount installed, but no fewer than 5 units.

PART 2 - PRODUCTS

2.01 PIPES, TUBES, AND FITTINGS:

A. Copper Medical Gas Tube: ASTM B819, 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 for Type L tube.
1. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
2. Wrought-Copper Fittings: ASME B16.22, solder joint pressure type or MSS SP-73, with dimensions for brazed joints.

3. Copper Unions: ASME B16.22 or MSS SP-123, wrought-copper or cast-copper alloy.
4. Memory-Metal Couplings: Cryogenic compression fitting made of ASTM F2063, nickel-titanium, shape-memory-alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.
    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        (1) Smart Technology, Inc.

2.02 JOINING MATERIALS:

A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.
B. Threaded-Joint Tape: PTFE.
C. Solvent Cement for Joining PVC Piping: ASTM D2564. Include primer complying with ASTM F656.

2.03 VALVES:

A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
B. Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
    1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        a. Allied Healthcare Products, Inc.; Chemetron Div.
        b. Amico Corporation.
        c. BeaconMedaes.
    2. Pressure Rating: 300 psig (2070 kPa) minimum.
    3. Ball: Full-port, chrome-plated brass or stainless steel.
    4. Seats: PTFE or TFE.
    5. Handle: Lever type with locking device.
    6. Stem: Blowout-proof with PTFE or TFE seal.
    7. Ends: Manufacturer-installed ASTM B819, copper-tube extensions.
C. Check Valves: In-line pattern, bronze.
    1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        a. Allied Healthcare Products, Inc.; Chemetron Div.
        b. Amico Corporation.
        c. BeaconMedaes.
    2. Pressure Rating: 300 psig (2070 kPa) minimum.
    3. Operation: Spring loaded.
    4. Ends: Manufacturer-installed ASTM B819, copper-tube extensions.
D. Zone Valves: MSS SP-110, 3-piece body, brass or bronze ball valve with gauge.
    1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        a. Allied Healthcare Products, Inc.; Chemetron Div.
        b. Amico Corporation.
        c. BeaconMedaes.
    2. Pressure Rating: 300 psig (2070 kPa) minimum.
    3. Ball: Full-port, chrome-plated brass.
    4. Seats: PTFE or TFE.
    5. Handle: Lever type with locking device.

6. Stem: Blowout-proof with PTFE or TFE seal.
7. Ends: Manufacturer-installed ASTM B819, copper-tube extensions.
8. Pressure Gauge: Manufacturer installed on one copper tube extension.

E. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gauges and in sizes required to permit manual operation of valves.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Allied Healthcare Products, Inc.; Chemetron Div.
b. Amico Corporation.
c. BeaconMedaes.
2. Interior Finish: Factory-applied white enamel.
3. Cover Plate: Aluminum or extruded-anodized aluminum with frangible or removable windows.
4. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

F. Emergency Oxygen Connections: Low-pressure oxygen inlet assembly for connection to building oxygen piping systems.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Allied Healthcare Products, Inc.; Chemetron Div.
b. Amico Corporation.
c. BeaconMedaes.
2. Enclosure: Weatherproof hinged locking cover with caption similar to "Emergency Low-Pressure Gaseous Oxygen Inlet."
3. Inlet: Manufacturer-installed, NPS 2 (DN 50), ASTM B819, copper tubing with NPS 2 (DN 50) minimum ball valve and plugged inlet.
4. Safety Valve: Bronze-body, pressure relief valve set at 75 or 80 psig (520 or 550 kPa).
5. Instrumentation: Pressure gauge.

G. Safety Valves: Bronze-body, ASME-construction, poppet, pressure-relief type with settings to match system requirements.

H. Pressure Regulators: Bronze or Stainless-steel body and trim; spring loaded, diaphragm operated, relieving type; manual pressure setting adjustment; rated for 250 psig (1725 kPa) minimum inlet pressure; and capable of controlling delivered gas pressure within 0.5 psig for each 10 psig (5.0 kPa for each 100 kPa) inlet pressure.

2.04 MEDICAL GAS SERVICE CONNECTIONS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Allied Healthcare Products, Inc.; Chemetron Div. (Medstar/Oxequip)

B. General Requirements for Medical Gas Service Connections: For specific medical gas pressure and suction service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.
1. Roughing-in Assembly:
a. Steel outlet box for recessed mounting and concealed piping.

b. 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.
c. Double seals that will prevent gas leakage.
d. ASTM B819, NPS 3/8 (DN 10) copper outlet tube brazed to valve with service marking and tube-end dust cap.

2. Finishing Assembly:
   a. Brass housing with primary check valve.
   b. Double seals that will prevent gas leakage.
   c. Cover plate with gas service label.
3. Quick-Coupler Service Connections: Pressure outlets for carbon dioxide, nitrous oxide, nitrogen, and oxygen service connections with noninterchangeable 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.
4. Medstar/Oxequip Service Connections: Pressure outlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.
   a. Oxygen Service Connections: Medstar/Oxequip.
5. Cover Plates: One piece, stainless steel, with NAAMM AMP 503, No. 4 finish and permanent, color-coded, identifying label matching corresponding service.

2.05 GAS MANIFOLDS:

A. Medical Gas Manifolds: Comply with NFPA 99, Ch. 5, for high-pressure medical gas cylinders.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Healthcare Products, Inc.; Chemetron Div.
      b. Amico Corporation.
      c. BeaconMedaes.
   2. Central Control Panel Unit: Weatherproof cabinet, supply and delivery pressure gauges, electrical alarm system connections and transformer, indicator lights or devices, manifold connection, pressure changeover switch, line pressure regulator, shutoff valves, and safety valve.
   3. Manifold and Headers: Duplex, nonferrous-metal header for number of cylinders indicated, divided into two equal banks. Units include design for 2,000 psig (13.8 MPa) minimum inlet pressure, except nitrous oxide manifolds may be designed for 800 psig (5520 kPa) and carbon dioxide manifolds may be designed for 1,500 psig (10.35 MPa). Include cylinder bank headers with inlet (pigtail) connections complying with CGA V-1, individual inlet check valves, shutoff valve, pressure regulator, check valve, and pressure gauge.
   4. Operation: Automatic, pressure-switch-activated changeover from one cylinder bank to the other when first bank becomes exhausted, without line pressure fluctuation or resetting of regulators and without supply interruption by shutoff of either cylinder bank header.
   5. Medical Gas Manifolds: See drawings and coordinate with owner for number of cylinders connected to each manifold system.
   6. Medical Gas Cylinders: Will be furnished by Owner.

7. Label manifold control unit with permanent label identifying medical gas type and system operating pressure.
8. Mounting: Wall with mounting brackets for manifold control cabinet and headers.

2.06 MEDICAL GAS PIPING ALARM SYSTEMS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Allied Healthcare Products, Inc.; Chemetron Div.
B. Panels for medical gas piping systems may be combined in single panels with medical compressed air and medical vacuum piping systems.
C. Components: Designed for continuous service and to operate on power supplied from 120Vac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.
D. Pressure Switches or Pressure Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
   1. Low-Pressure Operating Range: 0 to 100 psig (0 to 690 kPa).
   2. High-Pressure Operating Range: Up to 250 psig (1725 kPa).
E. General Requirements for Medical Gas Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
   1. Mounting: Recessed installation.
   2. Enclosures: Fabricated from minimum 0.047-inch (1.2-mm) thick steel or minimum 0.05-inch (1.27-mm) thick aluminum, with knockouts for electrical and piping connections.
F. Area Alarm Panels: Separate trouble alarm signals; pressure and vacuum gauges; and indicators for medical gas piping systems.
   1. Include alarm signals when the following conditions exist:
      a. Medical Gases and Air: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).

2.07 GAS CYLINDER STORAGE RACKS:

A. Wall Storage Racks: Fabricate racks with chain restraints for upright cylinders as indicated or provide equivalent manufactured wall racks.
B. Freestanding Storage Racks: Fabricate racks as indicated or provide equivalent manufactured storage racks. Racks shall include chain restraints and provide means to securely anchor racks to floor.

2.08 SLEEVES:

A. See SECTION 22 05 17 – SLEEVES AND SEALS FOR PLUMBING PIPING.

2.09 ESCUTCHEONS:

A. See SECTION 22 05 18 – ESCUTCHEONS FOR PLUMBING PIPING.

2.10 GROUT:

A. Description: ASTM C1107, 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: 5,000 psi (34.5 MPa), 28 day compressive strength.
   3. Packaging: Premixed and factory packaged.

2.11 NITROGEN:

A. Description: Comply with USP 28 - NF 23 for oil-free dry nitrogen.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are 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, gauges, 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 EARTHWORK:

A. Comply with requirements in DIVISION 31 for excavating, trenching, and backfilling and for underground warning tapes.

3.03 PIPING APPLICATIONS:

A. Medical Gas Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

3.04 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, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
B. Comply with ASSE 6010 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, and special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications below 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 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 seismic restraints on gas piping. Seismic restraint devices are specified in SECTION 22 05 48 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT.
M. Install firestopping systems for piping penetration of rated walls, ceiling, and floor. Comply with requirements for firestopping specified in SECTION 07 84 13 – PENETRATION FIRESTOPPING.
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 piece of equipment and specialty.

3.05 VALVE APPLICATIONS:
A. Valves for Copper Gas Tubing: Use copper alloy ball and bronze check types.

3.06 VALVE INSTALLATION:
A. Install shutoff valve at each connection to gas healthcare equipment and specialties.
B. Install check valves to maintain correct direction of gas flow from 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 gauges in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.
E. Install pressure regulators on gas piping where reduced pressure is required.
F. Install emergency oxygen connection with pressure relief valve and full-size discharge piping to outside, with check valve downstream from pressure relief valve and with ball valve and check valve in supply main from bulk oxygen storage tank.

3.07 JOINT CONSTRUCTION:
A. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
B. Threaded Joints: Apply appropriate tape to external pipe threads.
C. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free, dry nitrogen during brazing.
D. Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of memory-metal coupling joints.

3.08 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.
B. Install nitrogen pressure control panels in walls. Attach to substrate.
C. Assemble ceiling columns and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.

D. Assemble ceiling assemblies and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.
E. Install gas manifolds anchored to substrate.
F. Install gas cylinders and connect to manifold piping.
G. Install gas manifolds with seismic restraints as indicated.

3.09 MEDICAL GAS PIPING ALARM SYSTEM INSTALLATION:

A. Install medical gas alarm system components in locations required by and according to NFPA 99.
B. Install medical gas area and master alarm panels where indicated.

3.10 SLEEVE INSTALLATION:

A. Sleeves are not required for core-drilled holes.
B. Permanent sleeves are not required for holes formed by removable PE sleeves.
C. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs using galvanized-steel pipe.
   1. Wall Penetrations: Cut sleeves to length for mounting flush with both surfaces.
   2. Floor Penetrations: 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.
D. Install sleeves in new walls and slabs as new walls and slabs are constructed.
E. Install sleeves that are large enough to provide 1/4 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 NPS 6 (DN 150).
   2. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum board partitions.
   3. 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. Comply with requirements in DIVISION 07.
      a. Seal space outside of sleeve fittings with grout.
F. Fire Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in DIVISION 07.

3.11 ESCUTCHEON INSTALLATION:

A. Install escutcheons for penetrations of walls, ceilings, and floors per SECTION 22 05 18 ESCUTCHEONS FOR PLUMBING PIPING.

3.12 HANGER AND SUPPORT INSTALLATION:

A. Comply with requirements in SECTION 22 05 48 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT for seismic-restraint devices.
B. Comply with requirements in SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING and Equipment for pipe hanger and support devices.
C. Vertical Piping: MSS Type 8 or 42 clamps.
D. Individual, Straight, Horizontal Piping Runs:
   1. MSS Type 1, adjustable, steel, clevis hangers.

E. Base of Vertical Piping: MSS Type 52, spring hangers.
F. Support horizontal piping within 12 inches (300 mm) of each fitting and coupling.
G. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.
H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1/4 (DN 8): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
   2. NPS 3/8 and NPS 1/2 (DN 10 and DN 15): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
   3. NPS 3/4 (DN 20): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
   4. NPS 1 (DN 25): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
   5. NPS 1-1/4 (DN 32): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
   6. NPS 1-1/2 (DN 40): 10 ft. (3 m) with 3/8-inch (10-mm) rod.
   7. NPS 2 (DN 50): 11 ft. (3.4 m) with 3/8-inch (10-mm) rod.
   8. NPS 2-1/2 (DN 65): 13 ft. (4 m) with 1/2-inch (13-mm) rod.
   9. NPS 3 (DN 80): 14 ft. (4.3 m) with 1/2-inch (13-mm) rod.
   10. NPS 3-1/2 (DN 90): 15 ft. (4.6 m) with 1/2-inch (13-mm) rod.
   11. NPS 4 (DN 100): 16 ft. (4.9 m) with 1/2-inch (13-mm) rod.
   12. NPS 5 (DN 125): 18 ft. (5.5 m) with 1/2-inch (13-mm) rod.
   13. NPS 6 (DN 150): 20 ft. (6 m) with 5/8-inch (16-mm) rod.
   14. NPS 8 (DN 200): 23 ft. (7 m) with 3/4-inch (19-mm) rod.
I. Install supports for vertical copper tubing every 10 ft. (3 m).

3.13 LABELING AND IDENTIFICATION:

A. Install identifying labels and devices for specialty gas piping, valves, and specialties. Comply with requirements in SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT.
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. Nitrogen: White letters on black background.
   3. Nitrous Oxide: White letters on blue background.
   4. Oxygen: White letters on green background.

3.14 FIELD QUALITY CONTROL FOR HEALTHCARE FACILITY MEDICAL GAS:

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections of medical gas piping systems in healthcare facilities and prepare test reports.
   1. Also engage commissioning agent to witness testing
B. Perform tests and inspections of medical gas piping systems in healthcare facilities and prepare test reports.
C. 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 6010:
      a. Initial blow down.

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: Comply with requirements in NFPA 99, ASSE 6020, and ASSE 6030 for verification of medical gas piping systems and perform the following tests and inspections:
   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 the following source equipment:
      (1) 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.

D. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.15 DEMONSTRATION:

A. Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain medical gas alarm system. Refer to DIVISION 01.

END OF SECTION 22 63 13

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SECTION 22 64 00 – MEDICAL GAS ALARMS

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:
   1. Area alarm panels.

1.03 DEFINITIONS:

A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50V or for remote-control, signaling power-limited circuits.

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. Product Test Reports: For each alarm panel, for tests performed by a qualified testing agency.
C. Field quality control reports.

1.06 CLOSEOUT SUBMITTALS:

A. Operation and Maintenance Data: For alarm panels to include in emergency, operation, and maintenance manuals.

1.07 QUALITY ASSURANCE:

A. Installer Qualifications: Qualify Installers for air, vacuum, and gas 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 air, vacuum, and gas piping testing indicated, that is an NRTL, and that is acceptable to authorities having jurisdiction.
   1. Qualify testing personnel for air, vacuum, and gas piping systems for healthcare facilities according to ASSE Standard #6020 for medical-gas-system inspectors and ASSE Standard #6030 for medical-gas-system verifiers.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION:

A. Gas and Vacuum Systems Monitored:
   1. Carbon dioxide, designated "Carbon Dioxide (CO)."
   2. Medical compressed air, designated "Medical Air (MA)."
   3. Medical-surgical vacuum, designated "Medical Vacuum (MV)."
   4. Nitrogen, designated "Nitrogen (N)."
   5. Nitrous oxide, designated "Nitrous Oxide (NO)."
   6. Oxygen, designated "Oxygen (O2)."
   7. Waste anesthetic gas disposal, designated "WAGD."

2.02 MANUFACTURERS:

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Allied Healthcare Products, Inc.; Chemetron Division.

B. Source Limitations: Obtain medical alarm systems and components from single manufacturer.

2.03 GENERAL REQUIREMENTS FOR ALARM PANELS:

A. Description: Factory wired with audible and color-coded visible signals to indicate specified functions.
   1. Mounting: Recessed installation.
   2. Enclosures: Fabricated from minimum 0.047-inch (1.2-mm) thick steel or minimum 0.05-inch (1.27-mm) thick aluminum, with knockouts for electrical and piping connections.

B. Components: Designed for continuous service and to operate on power supplied from 120Vac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.

C. Dew Point Monitors: Continuous line monitoring, having panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, factory- or field-installed valved bypass, and visual and cancelable audio signal for dryer site and master alarm panels. Alarm signals when pressure dew point rises above 39ºF (4ºC) at 55 psig (380 kPa).
   1. Operation: Chilled mirror method or hygrometer moisture analyzer with sensor probe.

D. Pressure Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
   1. Low Pressure Operating Range: 0 to 100 psig (0 to 690 kPa).
   2. High Pressure Operating Range: Up to 250 psig (1725 kPa).

E. Carbon Monoxide Monitors: Panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, and factory- or field-installed valved bypass. Alarm signals when carbon monoxide level rises above 10 ppm.

F. Vacuum Switches or Pressure Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
   1. Vacuum Operating Range: 0 to 30 inches Hg (0 to 760 mm Hg).

2.04 AREA ALARM PANELS:

A. Area Alarm Panels <Zone Alarm Panel>: Separate trouble alarm signals and indicators for each system.
   1. Standards: Comply with NFPA 99 and UL 544.
   2. 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.
   3. Include alarm signals when the following condition exists:
      a. Medical Air: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).
      b. Medical Vacuum: Vacuum drops below 12 inches Hg (305 mm Hg).
      c. Oxygen: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).

PART 3 - EXECUTION

3.01 ALARM PANEL INSTALLATION:

A. Install alarm panels in locations required by and according to NFPA 99.

3.02 CONNECTIONS:

A. Comply with requirements for piping specified in DIVISION 22, SECTIONS "COMPRESSED AIR PIPING FOR LABORATORY AND HEALTHCARE FACILITIES," "Vacuum Piping for Laboratory and Healthcare Facilities," and "Gas Piping for Laboratory and Healthcare Facilities." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to alarm panels, allow space for service and maintenance.

3.03 IDENTIFICATION:

A. Identify system components. Comply with requirements for identification specified in DIVISION 22, SECTION "IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT" and according to NFPA 99.

3.04 FIELD QUALITY CONTROL:

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
   1. Also engage commissioning agent to witness testing.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. Perform each visual and mechanical inspection.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning panels and equipment.

D. Alarm panels will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.05 STARTUP SERVICE:

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.06 ADJUSTING:

A. Adjust initial alarm panel pressure and vacuum set points.

3.07 DEMONSTRATION:

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain alarm panels.

END OF SECTION 22 64 00

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SECTION 23 05 13 – COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

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 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 600V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.03 REFERENCE STANDARDS:

A. Applicable Standards (latest edition):
   1. National Electrical Manufacturers Association (NEMA):
      a. NEMA MG 1 - Motors and Generators.

1.04 COORDINATION:

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
   1. Motor controllers.
   2. Torque, speed, and horsepower requirements of the load.
   3. Ratings and characteristics of supply circuit and required control sequence.
   4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.01 GENERAL MOTOR REQUIREMENTS:

A. Comply with requirements in this SECTION except when stricter requirements are specified in HVAC equipment schedules or Sections.
B. Comply with NEMA MG 1 unless otherwise indicated.

2.02 MOTOR CHARACTERISTICS:

A. Duty: Continuous duty at ambient temperature of 40º and at altitude of 750 feet above sea level.
B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.03 POLYPHASE MOTORS:

A. Description: NEMA MG 1, Design B, medium induction motor.
B. Efficiency: Energy efficient, as defined in NEMA MG 1.
C. Service Factor: 1.15.
D. Rotor: Random-wound, squirrel cage.
E. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
F. Temperature Rise: Match insulation rating.
G. Insulation: Class F.
H. Code Letter Designation:
   1. Motors 15 HP and Larger: NEMA starting Code F or Code G.

2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

I. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.04 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS:

A. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Bearing Protection: All motors operated on variable frequency drives shall be equipped with maintenance free, 360 degree circumferential conductive micro fiber shaft grounding ring with a minimum two continuous rows of conductive micro fibers completely surrounding the motor shaft to discharge electrical shaft voltages away from the motor's bearings to ground. Note: Friction/spring contact brushes shall not be acceptable.
3. Application Note: Motors up to 100HP shall be provided with a minimum of one shaft grounding ring as described above installed by the manufacturer internally to the motor or externally on the drive end. Motors over 100HP shall be provided with an insulated bearing on the non-drive end and a shaft grounding ring on the drive end of the motor. Grounding rings shall be provided and installed by the motor manufacturer or contractor and shall be installed in accordance with the manufacturer's recommendations. Note: Grounding rings are to be manuractured by Aegis or Helwig Carbon BPK..
4. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
5. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
6. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

B. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.05 SINGLE-PHASE MOTORS:

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 23 05 13

SECTION 23 05 16 – EXPANSION FITTINGS AND LOOPS FOR HVAC 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.

1.02 SUMMARY:

A. This SECTION includes:
   1. Alignment guides and anchors.

1.03 REFERENCE STANDARDS:

A. Applicable Standards (Latest Edition):
   1. American Welding Society (AWS):
      a. AWS D1.1/D1.1M - Structural Welding Code - Steel.
   2. ASME International (ASME):
      a. ASME B18.10 - Track Bolts and Nuts.
      b. ASME B31.9 - Building Services Piping.
      c. ASME Boiler and Pressure Vessel Code: Section II, "Materials"; Section IX, "Welding and Brazing Qualifications."
   3. ASTM International (ASTM):
      a. ASTM A36/A36M - Specification for Carbon Structural Steel.
      b. ASTM A53/A53M - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      c. ASTM A183 - Specification for Carbon-Steel Track Bolts and Nuts.
      d. ASTM A307 - Specification for Carbon-Steel Bolts and Studs, 60,000 PSI Tensile Strength.
      e. ASTM C881/C881M - Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
      f. ASTM F844 REV A - Specification for Washers, Steel, Plain (Flat), Unhardened for General Use.

1.04 PERFORMANCE REQUIREMENTS:

A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.

B. Capability: Products to absorb 200% of maximum axial movement between anchors.

1.05 SUBMITTALS:

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

B. Submittal: For each anchor and alignment guide indicated to comply with performance requirements and design criteria stated by engineer preparation.
   1. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
   2. Alignment Guide Details: Detail field assembly and attachment to building structure.
   3. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion loop and joining.

C. Welding Procedure Specification (WPS) and Welder Performance Qualification Record (WPQR)

1.06 QUALITY ASSURANCE:

A. Steel Support Welding: Qualify welding procedures, welders, and welding operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Welding: Weld piping in accordance with qualified procedures using performance qualified welders and welding 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 ASME IX qualification tests for welding processes involved and that certification is current.

PART 2 - PRODUCTS

2.01 ALIGNMENT GUIDES AND ANCHORS:

A. Alignment Guides:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
   a. Adsco Manufacturing, LLC.
   b. Advanced Thermal Systems, Inc.
   c. Hyspan Precision Products, Inc.
   d. Metraflex, Inc.
   e. Unisource Manufacturing, Inc.
   f. U.S. Bellows, Inc.
2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.

B. Anchor Materials:

1. Steel Shapes and Plates: ASTM A36/A36M.
2. Bolts and Nuts: ASME B18.10 or ASTM A183, steel hex head.
3. Washers: ASTM F844 REV A, steel, plain, flat washers.
4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened Portland cement concrete, with tension and shear capacities appropriate for application.
   a. Stud: Threaded, zinc-coated carbon steel.
   b. Expansion Plug: Zinc-coated steel.
   c. Washer and Nut: Zinc-coated steel.
5. Chemical Fasteners: Insert-type-stud, bonding-system anchor for use with hardened Portland cement concrete, with tension and shear capacities appropriate for application.
   a. Bonding Material: ASTM C881/C881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
   b. Stud: ASTM A307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
   c. Washer and Nut: Zinc-coated steel

2.02 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION:

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install one guide on each side of pipe expansion loops and where indicated on plans. Install guides nearest to expansion loop not more than four pipe diameters from first and last joint of the expansion loop.
C. Attach guides to pipe and secure guides to building structure.
D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
E. Anchor Attachments:
    1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
    2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.
F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
    1. Anchor Attachment to Steel Structural Members: Attach by welding.
    2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 23 05 16

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SECTION 23 05 17 – SLEEVES AND SLEEVE SEALS FOR HVAC 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.

1.02 SUMMARY:

A. This SECTION includes:
   1. Sleeves.
   2. Sleeve-seal systems.
   3. Grout.

1.03 REFERENCE STANDARDS:

A. Applicable Standards (Latest Edition):
   1. ASTM International (ASTM):
      a. ASTM A53/A53M - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
      b. ASTM C1107/C1107M - Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).

1.04 SUBMITTALS:

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

PART 2 - PRODUCTS

2.01 SLEEVES:

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
B. Galvanized-Steel Wall Pipes: ASTM A53/A53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
C. Galvanized-Steel-Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

2.02 SLEEVE-SEAL SYSTEMS:

A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following:
   1. Advance Products & Systems, Inc.
   2. CALPICO, Inc.
   3. Metraflex Company (The).
   4. Link-Seal.
   5. Hilti.
B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
   1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Stainless steel.

3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.03 GROUT:

A. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
B. Characteristics: Nonshrink; recommended for interior and exterior applications.
C. Design Mix: 5,000-psi , 28-day compressive strength.
D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.01 SLEEVE INSTALLATION:

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1 inch annular clear space between piping and concrete slabs and walls.
   1. Sleeves are not required for core-drilled holes.
C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
   2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
D. Install sleeves for pipes passing through rated interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4 inch (6.4 mm) annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in DIVISION 07.
E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in DIVISION 07.

3.02 SLEEVE-SEAL-SYSTEM INSTALLATION:

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.03 SLEEVE AND SLEEVE-SEAL SCHEDULE:

A. Use sleeves and sleeve seals for the following piping-penetration applications:
B. Use sleeves and sleeve seals for the following piping-penetration applications:
   1. Exterior Concrete Walls below Grade:

a. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.
(1) Select sleeve size to allow for 1 inch annular clear space between piping and sleeve for installing sleeve-seal system.

2. Concrete Slabs-on-Grade:
a. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.
(1) Select sleeve size to allow for 1 inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Interior Partitions:
a. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 23 05 17

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SECTION 23 05 18 – ESCUTCHEONS FOR HVAC 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.

1.02 SUMMARY:

A. This SECTION includes:
   1. Escutcheons.

1.03 SUBMITTALS:

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

PART 2 - PRODUCTS

2.01 ESCUTCHEONS:

A. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
   1. Escutcheons for New Piping:
      a. Insulated Piping: One-piece, stamped-steel type.
      b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
      c. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type.
      d. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel.
      e. Bare Piping in Equipment Rooms: One-piece, stamped-steel type.

3.02 FIELD QUALITY CONTROL:

A. Replace broken and damaged escutcheons using new materials.

END OF SECTION 23 05 18

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SECTION 23 05 19 – METERS AND GAGES FOR HVAC 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.

1.02 SUMMARY:

A. This SECTION includes:
   1. Bimetallic-actuated thermometers.
   2. Thermowells.
   3. Dial-type pressure gages.
   4. Gage attachments.
   5. Test plugs.
   6. Test-plug kits.
   7. Sight flow indicators.
   8. Orifice flowmeters.
   9. Pitot-tube flowmeters.
   10. Turbine flowmeters.
   11. Venturi flowmeters.
   12. Vortex-shedding flowmeters.
   13. Impeller-turbine, thermal-energy meters.
   14. Ultrasonic, thermal-energy meters.

B. Related Sections.
   1. SECTION 23 22 13 - STEAM AND CONDENSATE HEATING PIPING for steam and condensate meters.

1.03 REFERENCE STANDARDS:

A. Applicable Standards (Latest Editions):
   1. ASME International (ASME):
      a. ASME B1.1 - Unified Inch Screw Threads, UN and UNR Thread Form.
      b. ASME B1.20.1 - Pipe Threads, General Purpose, Inch.
      c. ASME B40.100 - Pressure Gauges and Gauge Attachments.
      d. ASME B40.200 - Thermometers, Direct Reading and Remote Reading.

1.04 SUBMITTALS:

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

B. Wiring Diagrams: For power, signal, and control wiring.

C. Product Certificates: For each type of meter and gage, from manufacturer.

D. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 BIMETALLIC-ACTUATED THERMOMETERS:

Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ashcroft Inc.
   2. Ernst Flow Industries.

3. Tel-Tru Manufacturing Company.
4. Trerice, H. O. Co.
5. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
6. Weiss Instruments, Inc.
7. Winters Instruments - U.S.

B. Standard: ASME B40.200.
C. Case: sealed type; stainless steel with 5 inch nominal diameter.
D. Dial: Non-reflective aluminum with permanently etched scale markings and scales in ºF.
E. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.
F. Connector Size: 1/2 inch, with ASME B1.1 screw threads.
G. Stem: 0.25 or 0.375 inch in diameter; stainless steel.
H. Window: Plain glass.
I. Ring: Stainless steel.
J. Element: Bimetal coil.
K. Pointer: Dark-colored metal.
L. Accuracy: ±1 % of scale range.

2.02 DUCT-THERMOMETER MOUNTING BRACKETS:

A. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

2.03 THERMOWELLS:

A. Thermowells:
1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR.
4. Material for Use with Steel Piping: CRES.
5. Type: Stepped shank, unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch (13, 19, and 25 mm), with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.04 PRESSURE GAGES:

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
1. Manufacturers: Subject to compliance with requirements, ŧprovide products by one of the following:
a. Ashcroft, Inc.
b. Ernst Flow Industries.
c. Flo Fab, Inc.
d. Tel-Tru Manufacturing Company.
e. Trerice, H. O. Co.
f. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.

g. Weiss Instruments, Inc.
h. Winters Instruments - U.S.
2. Standard: ASME B40.100.
3. Case: Sealed type; cast aluminum or drawn steel; 4-1/2 inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type, unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Non-reflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Metal.
11. Accuracy: Grade A, ±1% of middle half of scale range.

2.05 GAGE ATTACHMENTS:

A. Snubbers: ASME B40.100, brass; with NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.
B. Siphons: Loop-shaped section of stainless-steel pipe with NPS 1/2 pipe threads.
C. Valves: Brass or stainless-steel needle, with NPS 1/2, ASME B1.20.1 pipe threads.

2.06 TEST PLUGS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. National Meter, Inc.
2. Peterson Equipment Co., Inc.
3. Sisco Manufacturing Company, Inc.
4. Trerice, H. O. Co.
5. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
6. Weiss Instruments, Inc.
B. Description: Test-station fitting made for insertion into piping tee fitting.
C. Body: Brass or stainless steel with core inserts and gasketed and brass threaded cap. Include extended stem on units to be installed in insulated piping. Plastic threaded caps will not be allowed.
D. Thread Size: NPS 1/, ASME B1.20.1 pipe thread.
E. Minimum Pressure and Temperature Rating: 500 psig at 200ºF.
F. Core Inserts: EPDM self-sealing rubber.

2.07 FLOWMETERS:

A. Vortex-Shedding Flowmeters:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. ABB; Instrumentation and Analytical.
b. Eastech Flow Controls.
c. EMCO Flow Systems; a division of Spirax Sarco, Inc.
d. Emerson Process Management; Rosemount.
e. Endress+Hauser.
2. Description: Flowmeter with sensor and indicator.

3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
4. Sensor: Inline type; for installing between pipe flanges and measuring flow directly in gallons per minute (liters per second).
    a. Design: Flow obstruction device, vortex-measurement type for steam and liquids.
    b. Construction: Stainless-steel body, with integral transmitter and direct-reading scale.
    c. Minimum Pressure Rating: 1,000 psig.
    d. Minimum Temperature Rating: 500ºF.
    e. Integral Transformer: For low-voltage power operation.
5. Indicator: Handheld meter; either an integral part of sensor or a separate meter.
6. Accuracy: ±0.25 % for liquids and 0.75 % for gases.
7. Display: Shows rate of flow, with register to indicate total volume in gallons.
8. Operating Instructions: Include complete instructions with each flowmeter.

2.08 THERMAL-ENERGY METERS:

A. Ultrasonic, Thermal-Energy Meters:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. EMCO Flow Systems; a division of Spirax Sarco, Inc.
    b. Siemens Energy & Automation, Inc.
2. Description: Meter with flow sensor, temperature sensors, transmitter, indicator, and connecting wiring.
3. Flow Sensor: Transit-time ultrasonic type with transmitter.
4. Temperature Sensors: Insertion-type or strap-on transducer.
5. Indicator: Solid-state, integrating-type meter with integral battery pack.
    a. Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or British thermal units.
    b. Battery Pack: Five-year lithium battery.
6. Accuracy: ±1%.
7. Display: Visually indicates total fluid volume in gallons and thermal-energy flow in kilowatts per hour or British thermal units.
8. Operating Instructions: Include complete instructions with each thermal-energy meter system.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.
B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
C. Install thermowells with extension on insulated piping.
D. Fill thermowells with heat-transfer medium.
E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.
G. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.

H. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
I. Install valve and snubber in piping for each pressure gage for fluids (except steam).
J. Install valve and syphon fitting in piping for each pressure gage for steam.
K. Install test plugs in piping tees.
L. Install flow indicators in piping systems in accessible positions for easy viewing.
M. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.
N. Install flowmeter elements in accessible positions in piping systems.
O. Install differential-pressure type flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.
P. Install permanent indicators on walls or brackets in accessible and readable positions.
Q. Install connection fittings in accessible locations for attachment to portable indicators.
R. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.
S. Install thermometers in the following locations:
    1. Inlet and outlet of each hydronic zone.
    2. e.
    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.
T. Install pressure gages in the following locations:
    1. Discharge of each pressure-reducing valve.
    2. Inlet and outlet of each chiller chilled-water connection.
    3. Suction and discharge of each pump.
    4. Inlet and Outlet of each hydronic coil.
    5. Inlet and outlet of each hydronic heat exchanger
    6. Inlet of steam service to each heat exchanger

3.02 CONNECTIONS:

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.
B. Connect flowmeter-system elements to meters.
C. Connect flowmeter transmitters to meters.
D. Connect thermal-energy meter transmitters to meters.

3.03 ADJUSTING:

A. After installation, calibrate meters according to manufacturer's written instructions.
B. Adjust faces of meters and gages to proper angle for best visibility.

3.04 THERMOMETER SCHEDULE:

A. Thermometers at inlet and outlet of each hydronic zone shall be the following:
    1. Sealed, bimetallic-actuated type.
    2. Test plug with EPDM self-sealing rubber inserts.
B. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems shall be the following:
    1. Sealed, bimetallic-actuated type.
    2. Test plug with EPDM self-sealing rubber inserts.

C. Thermometers at inlets and outlets of each hydronic heat exchanger shall be the following:
   1. Sealed, bimetallic-actuated type.
   2. Test plug with EPDM self-sealing rubber inserts.
D. Thermometers at inlet and outlet of each hydronic heat-recovery unit shall be the following:
   1. Sealed, bimetallic-actuated type.
   2. Test plug with EPDM self-sealing rubber inserts.
E. Thermometers at inlet and outlet of each thermal-storage tank shall be the following:
   1. Sealed, bimetallic-actuated type.
   2. Test plug with EPDM self-sealing rubber inserts.
F. Thermometers at outside-, return-, supply-, and mixed-air ducts shall be the following:
   1. Sealed, bimetallic-actuated type.
G. Thermometer stems shall be of length to match thermowell insertion length.

3.05 THERMOMETER SCALE-RANGE SCHEDULE:
A. Scale Range for Chilled-Water Piping: 0 to 100ºF.
B. Scale Range for Heating, Hot-Water Piping: 0 to 250ºF.
C. Scale Range for Steam and Steam-Condensate Piping: 30 to 240ºF.
D. Scale Range for Air Ducts: 0 to 150ºF.

3.06 PRESSURE GAGE SCHEDULE:
A. Pressure gages at discharge of each pressure-reducing valve shall be the following:
   1. Sealed, direct-mounted, metal case.
   2. Test plug with EPDM self-sealing rubber inserts.
B. Pressure gages at suction and discharge of each pump shall be the following:
   1. Sealed, direct-mounted, metal case.
   2. Test plug with EPDM self-sealing rubber inserts.

3.07 PRESSURE GAGE SCALE-RANGE SCHEDULE:
A. Scale Range for Chilled-Water Piping: 0 to 100 psi.
B. Scale Range for Heating, Hot-Water Piping: 0 to 200 psi.
C. Scale Range for Steam Piping: 0 to 200 psi.

3.08 FLOWMETER SCHEDULE:
A. Flowmeters for Chilled-Water Piping: Vortex-shedding type.
B. Flowmeters for Heating, Hot-Water Piping: Vortex-shedding type.
C. Flowmeters for Steam and Steam-Condensate Piping: Vortex-shedding type.

3.09 THERMAL-ENERGY METER SCHEDULE:
A. Thermal-Energy Meters for Chilled-Water Piping: Ultrasonic type.
B. Thermal-Energy Meters for Heating, Hot-Water Piping: Ultrasonic type.
C. Thermal-Energy Meters for Steam and Steam-Condensate Piping: Ultrasonic type.

END OF SECTION 23 05 19

ECTION 23 05 23 – GENERAL-DUTY VALVES FOR HVAC 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.

1.02 SUMMARY:

A. This SECTION includes:
   1. Bronze ball valves.
   2. Iron, lug style butterfly valves.
   3. High-performance butterfly valves.
   4. Bronze swing check valves.
   5. Iron swing check valves.
   6. Iron spring check valves.
   7. Bronze gate valves.
   8. Iron gate valves.
   9. Chainwheels.

1.03 RELATED REQUIREMENTS:

A. DIVISION 23 - HVAC Piping Sections for specialty valves applicable to those sections only.
B. SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT for valve tags and schedules.

1.04 REFERENCE STANDARDS:

A. Applicable Standards (Latest Edition):
   1. American Water Works Association (AWWA):
   2. AWWA C606 - Grooved and Shouldered Joints.
   3. ASME International (ASME):
   4. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).
   5. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
   6. ASME B16.10 - Face-to-Face and End-to-End Dimensions of Valves.
   7. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
   8. ASME B16.34 - Valves - Flanged, Threaded, and Welding End.
   9. ASME B31.1 - Power Piping.
   10. ASME B31.9 - Building Services Piping.
   11. ASTM International (ASTM):
   12. ASTM A48/A48M - Specification for Gray Iron Castings.
   13. ASTM A126 - Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   14. ASTM A536 - Specification for Ductile Iron Castings.
   15. ASTM B61 - Specification for Steam or Valve Bronze Castings.
   16. ASTM B62 - Specification for Composition Bronze or Ounce Metal Castings.
   17. Manufacturers Standardization Society of The Valve and Fittings Industry, Inc. (MSS):
   18. MSS SP-45 - Bypass and Drain Connections.
   19. MSS SP-67 - Butterfly Valves.
   20. MSS SP-68 - High Pressure Butterfly Valves with Offset Design.
   21. MSS SP-70 - Cast Iron Gate Valves, Flanged and Threaded Ends.

22. MSS SP-110 - Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.05 DEFINITIONS:

A. CWP: Cold working pressure.
B. EPDM: Ethylene propylene copolymer rubber.
C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
D. NRS: Nonrising stem.
E. OS&Y: Outside screw and yoke.
F. RS: Rising stemSWP: Steam working pressure.

1.06 SUBMITTALS:

A. Product Data: For each type of valve indicated.

1.07 QUALITY ASSURANCE:

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
B. ASME Compliance:
   1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   2. ASME B31.1 for power piping valves.
   3. ASME B31.9 for building services piping valves.

1.08 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 and plug 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 GENERAL REQUIREMENTS FOR VALVES:

A. Refer to HVAC valve schedule articles for applications of valves.
B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
C. Valve Sizes: Same as upstream piping, unless otherwise indicated.
D. Valve Actuator Types:
   1. Gear Actuator: For quarter-turn valves NPS 4 and larger.
   2. Handwheel: For valves other than quarter-turn types.
   3. Hand lever: For quarter-turn valves NPS 6 and smaller.

4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:
1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: With extended neck.

F. Valve-End Connections:
1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Solder Joint: With sockets according to ASME B16.18.
3. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.02 BRONZE BALL VALVES:

A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Conbraco Industries, Inc.; Apollo Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Nibco
d. Viega ProPress 2973
2. Description:
a. Standard: MSS SP-110.
b. SWP Rating: 150 psig (1035 kPa).
c. CWP Rating: 600 psig (4140 kPa).
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: EPDM.
h. Stem: Stainless steel.
i. Ball: Stainless steel,.
j. Port: Full.

2.03 IRON, LUG STYLE BUTTERFLY VALVES:

A. 250 CWP, Iron, Lug Style Butterfly Valves with EPDM Seat:
1. Manufacturers: Subject to compliance with requirements,:
a. Conbraco Industries, Inc.; Apollo Valves.
b. Crane Co.; Crane Valve Group; Center Line.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Grinnel
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-67, Type I.
b. CWP Rating: 250 psig (1035 kPa) at 250 ºF.

c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
e. Seat: EPDM.
f. Stem: One-piece stainless steel.
g. Disc: Nickel-plated ductile iron aluminum bronze.

2.04 HIGH PERFORMANCE BUTTERFLY VALVES:

A. Class 150, lug type, offset stainless steel disc
1. Manufacturers: Subject to compliance with requirements:
a. Adams: MAK
b. Bray: Trilok
c. Velan: Torqseal
d. Zwick: Tri-Con
2. Description
a. Class 150 Lug
b. ISO face to face
c. Carbon steel body
d. Stainless Steel disc
e. Laminated graphite and stainless steel valve seal
f. Manual gear operator with handwheel open/close

2.05 BRONZE SWING CHECK VALVES:

A. Class 125, Bronze Swing Check Valves with Bronze Disc:
1. Manufacturers: Subject to compliance with requirements:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Powell Valves.
g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Horizontal flow.
d. Body Material: ASTM B62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

B. Class 150, Bronze Swing Check Valves with Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Kitz Corporation.
e. Milwaukee Valve Company.
f. NIBCO INC.

2. Description:
   a. Standard: MSS SP-80, Type 3.
   b. CWP Rating: 300 psig (2070 kPa).
   c. Body Design: Horizontal flow.
   d. Body Material: ASTM B62, bronze.
   e. Ends: Threaded.
   f. Disc: Bronze.

2.06 BRONZE GATE VALVES:

A. Class 150, NRS Bronze Gate Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Milwaukee Valve Company.
      b. NIBCO INC.
      c. Powell Valves.
      Watts Regulator Co.
   2. Description:
      a. Standard: MSS SP-80, Type 1.
      b. CWP Rating: 300 psig (2070 kPa).
      c. Body Material: ASTM B62, bronze with integral seat and union-ring bonnet.
      d. Ends: Threaded.
      e. Stem: Bronze.
      f. Disc: Solid wedge; bronze.
      g. Packing: Asbestos free.
      h. Handwheel: aluminum.

2.07 IRON GATE VALVES:

A. Class 125, NRS, Iron Gate Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. Crane Co.; Crane Valve Group; Jenkins Valves.
      c. Crane Co.; Crane Valve Group; Stockham Division.
      d. Milwaukee Valve Company.
      e. NIBCO INC.
      f. Powell Valves.
      g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   2. Description:
      a. Standard: MSS SP-70, Type I.
      b. NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig .
      c. NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig).
      d. Body Material: ASTM A126, gray iron with bolted bonnet.
      e. Ends: Flanged.
      f. Trim: Bronze.
      g. Disc: Solid wedge.
      h. Packing and Gasket: Asbestos free.

2.08 IRON SPRING LOADED CHECK VALVES:

A. Class 125/150, Iron Spring Loaded Non Slam Check Valves :
   1. Manufacturers: Subject to compliance with requirements:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. Crane Co.; Crane Valve Group; Jenkins Valves.
      c. Crane Co.; Crane Valve Group; Stockham Division.
      d. Milwaukee Valve Company.
      e. NIBCO INC.
      f. Powell Valves.
      g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   2. Description:
      a. Body Design: Vertical flow.
      b. Body Material: Steel.
      c. Ends: Lug
      d. Disc: Steel
      e. Dual element spring loaded "H" style backflow device

2.09 CAST STEEL GATE VALVE – FLANGED

A. Class 150, OS&Y
   1. Manufacturers: Subject to compliance with requirements:
      a. Crane: No. 47XFU
      b. Stockham: 15-OF-U
      c. Kitz: K150 SCL
   2. Description:
      a. Flanged
      b. Cast Steel
      c. OS&Y
      d. Half Satellite

2.10 CHAINWHEELS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Babbitt Steam Specialty Co.
   2. Roto Hammer Industries.
B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
   1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
   2. Attachment: For connection to ball and butterfly valve stems.
   3. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve.
   4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.
D. 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.
E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION:

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
B. Locate valves for easy access and provide separate support where necessary.
C. Install valves in horizontal piping with stem at or above center of pipe.
D. Install valves in position to allow full stem movement.
E. Install chainwheels on operators for ball, butterfly and gate valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.
F. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.

3.03 ADJUSTING:

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS:

A. If valve applications are not indicated, use the following:
   1. Shutoff Service: Ball, butterfly or gate valves.
   2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
   3. Throttling Service except Steam: ball, or butterfly valves.
   4. Throttling Service, Steam: butterfly valves.
   5. Pump-Discharge Check Valves:
      a. NPS 2 (DN 50) and Smaller: Bronze center guide lift check valves with bronze disc.
      b. NPS 2-1/2 (DN 65) and Larger: Iron center guide lift check valves with spring, center-guided, metal-seat check valves.
B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
C. Select valves, except wafer types, with the following end connections:
   1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
   2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
   3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
   4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
   5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
   6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.

3.05 CHILLED-WATER, LOW TEMP (GLYCOL) COOLING WATER, AND HEATING HOT WATER VALVE SCHEDULE:

A. Pipe NPS 2-1/2 (DN 65) and Smaller:

1. Bronze Ball Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
3. Bronze Swing Check Valves Class 150, bronze disc.

B. Pipe NPS 3 (DN 80) and Larger:
1. Iron Valves, NPS 3 and larger: May be provided with threaded ends instead of flanged ends.
2. Iron, Lug style Butterfly Valves, NPS 3 to NPS 12 (DN 65 to DN 300): 200 CWP, EPDM seat, aluminum-bronze disc.
3. Iron, Lug style Butterfly Valves, NPS 14 to NPS 24 (DN 350 to DN 600): 200 CWP, EPDM seat, aluminum-bronze disc.

3.06 LOW-PRESSURE STEAM VALVE SCHEDULE (15 PSIG (104 KPA) OR LESS):

A. Pipe NPS 2 (DN 50) and Smaller:
1. Bronze Gate Valves: Class 150, NRS.

B. Pipe NPS 2-1/2 (DN 65) and Larger:
1. Iron Valves, NPS 2-1/2 to NPS 12Provide with flanged ends.
2. Iron Gate Valves: Class 125, NRS.
3. High Performance Butterfly Valve

3.07 HIGH-PRESSURE STEAM VALVE SCHEDULE (UP TO 100 PSIG):

A. Pipe NPS 1-1/2” (DN 50) and Smaller:
1. Cast Steel Valves Class 150, NRS..

B. Pipe Sizes NPS 2-1/2 (DN 65) and Larger:
1. Cast Steel , NRS Gate Valve, Class 150.
2. Crane Figure 47 valve, no exceptions
3. High Performance Butterfly Valve

3.08 STEAM-CONDENSATE VALVE SCHEDULE:

A. Pipe NPS 2 (DN 50) and Smaller:
1. Bronze Swing Check Valves: Class 150, bronze disc.
2. Bronze Gate Valves: Class 150, NRS.

B. Pipe NPS 2-1/2 (DN 65) and Larger:
1. Iron Valves, NPS 2-1/2and larger: Provide with flanged ends.

END OF SECTION 23 05 23

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

PART 1 - GENERAL

1.01 SUMMARY:

A. This SECTION includes:
   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 supports.

1.02 RELATED REQUIREMENTS:

1. DIVISION 05 for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. SECTION 23 05 16 - EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING for pipe guides and anchors.
3. SECTION 23 05 48 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT for vibration isolation devices.
4. SECTION 23 31 13 - METAL DUCTS and SECTION 23 31 16 - NONMETAL DUCTS for duct hangers and supports.

1.03 REFERENCE STANDARDS:

A. Applicable Standards (Latest Edition):
   1. International Mechanical Code with Missouri Amendments
   2. American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI):
      a. ASCE/SEI 7 - Minimum Design Loads for Buildings and Other Structures.
   3. American Welding Society (AWS):
      a. AWS D1.1/D1.1M - Structural Welding Code - Steel.
   4. ASME International (ASME):
      a. ASME B31.9 - Building Services Piping.
      b. ASME Boiler and Pressure Vessel Code - Section IX, "Welding and Brazing Qualifications."
   5. ASTM International (ASTM):
      a. ASTM A36/A36M - Specification for Carbon Structural Steel.
      b. ASTM A780 - Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
      c. ASTM C533 - Specification for Calcium Silicate Block and Pipe Thermal Insulation.
      d. ASTM C552 - Specification for Cellular Glass Thermal Insulation.
      e. ASTM C591 - Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
      f. ASTM C1107 - Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink).
   6. Manufacturers Standardization Society of The Valve and Fittings Industry, Inc. (MSS):
      a. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture.
      b. MSS SP-69 - Pipe Hangers and Supports - Selection and Application.
      c. MSS SP-89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

7. Metal Framing Manufacturers Association, Inc. (MFMA):
   a. MFMA-4 - Metal Framing Standards Publication.
   b. MFMA-103 - Guidelines for the Use of Metal Framing.
8. The Society for Protective Coatings (SSPC):
   a. SSPC-PA 1 - Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel.

1.04 DEFINITIONS:

A. MSS: Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.

1.05 PERFORMANCE REQUIREMENTS:

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
   1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
   2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Spacing Requirements: Conform to International Mechanical Code with Missouri Ammendments for vertical and hotizontal minimum spacing requriements.

1.06 SUBMITTALS:

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

B. Shop Drawings Show fabrication and installation details and include calculations for the following; include Product Data for components:
   1. Trapeze pipe hangers.
   2. Metal framing systems.
   3. Fiberglass strut systems.
   4. Pipe stands.
   5. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Detail fabrication and assembly of trapeze hangers.
   2. Design Calculations: Calculate requirements for designing trapeze hangers.

D. Welding Procedure Specification (WPS) and Welder Performance Qualification Record (WPQR)

1.07 QUALITY ASSURANCE:

A. Structural Steel Welding Qualifications: Qualify welding procedures, welders, and welding operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Weld piping in accordance with qualified procedures using performance qualified welders and welding operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.01 METAL PIPE HANGERS AND SUPPORTS:

A. Carbon-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58 (except as noted in PART 3 - Execution), 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.

B. Stainless-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58 (except as noted in PART 3 - Execution), 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.

C. Copper Pipe Hangers:
   1. Description: MSS SP-58, Types 1 through 58 (except as noted in PART 3 - Execution), copper-coated-steel, factory-fabricated components.
   2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel or stainless steel.

2.02 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.

2.03 METAL FRAMING SYSTEMS:

A. MFMA Manufacturer Metal Framing Systems:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Cooper B-Line, Inc.
      b. Flex-Strut, Inc.
      c. Powerstrut Corp.
      d. Unistrut Corporation; Tyco International, Ltd.
   2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
   3. Standard: MFMA-4.
   4. Channels: Continuous slotted steel channel with inturned lips.
   5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
   6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.
   7. Metallic Coating: Electroplated zinc, Hot-dipped galvanized, or Mill galvanized.

2.04 THERMAL-HANGER SHIELD INSERTS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Carpenter & Paterson, Inc.
   2. PHS Industries, Inc.
   3. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
B. Insulation-Insert Material for Cold Piping: 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.
C. Insulation-Insert Material for Hot Piping: 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.
D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
F. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.05 FASTENER SYSTEMS:

A. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated 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: Plastic or 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.

2.08 MISCELLANEOUS MATERIALS:

A. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5,000-psi (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION:

A. All pipe hanger installations are to comply with International Mechanical Code for spacing requirements.

B. 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.

C. The following figure types given in Figure 1 of MSS SP-69 will not be acceptable: Types 5, 6, 7, 9, 10, 11, 12, 16, 19, 20, 23, 25, 27, 28, 29, and 30. However, Types 7, 9, 10, 11, 19, and 23 may be used for nonferrous and plastic piping systems 2 inches and smaller.

D. 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.

E. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

F. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

G. Fastener System Installation:

1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions. Do not use in lightweight concrete or in concrete slabs less than 4 inches thick. Powder activated fasteners will not be permitted.

H. 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 for curbs.

I. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

J. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

K. Install hangers and supports to allow controlled thermal 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.
L. Install lateral bracing with pipe hangers and supports to prevent swaying.
M. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (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.
N. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
O. 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.
P. Insulated Piping:
    1. Attach clamps and spacers to piping.
        a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
        b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
        c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
    2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
        a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
    3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
        a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
    4. Shield Dimensions for Pipe: Not less than the following:
        a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
        b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
        c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
        d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
        e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.
    5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
    6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.02 EQUIPMENT SUPPORTS:

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.03 METAL FABRICATIONS:

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and 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 qualified 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.

3.04 ADJUSTING:

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

3.05 PAINTING:

A. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

3.06 HANGER AND SUPPORT SCHEDULE:

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile and wet environment applications.

G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Exception: The following figure types given in Figure 1 of MSS SP-69 will not be acceptable: Types 5, 6, 7, 9, 10, 11, and 12. However, Types 7, 9, 10, and 11 may be used for nonferrous and plastic piping systems 2 inches and smaller.
2. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).

3. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1,050ºF (566ºC), pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.
4. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
5. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
6. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
7. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
8. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
9. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
10. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 (DN 65 to DN 900) if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
11. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction might occur.
12. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24 (DN 65 to DN 600), from single rod if horizontal movement caused by expansion and contraction might occur.
13. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 (DN 50 to DN 1050) if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
14. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 (DN 50 to DN 600) if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
15. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 (DN 50 to DN 750) if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Exception: The following figure type given in Figure 1 of MSS SP-69 will not be acceptable: Type 16.
2. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.

3. Steel Clevises (MSS Type 14): For 120 to 450ºF (49 to 232ºC) piping installations.
4. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450ºF (49 to 232ºC) piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following type
1. Exception: The following figure types given in Figure 1 of MSS SP-69 will not be acceptable: 19, 20, 23, 25, 27, 28, 29, 30, and 34.
2. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
4. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
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 pounds (340 kg).
   b. Medium (MSS Type 32): 1,500 pounds (680 kg).
   c. Heavy (MSS Type 33): 3,000 pounds (1360 kg).
6. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
7. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25% to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25% to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25% to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include

auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

a. Horizontal (MSS Type 54): Mounted horizontally.
b. Vertical (MSS Type 55): Mounted vertically.
c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

R. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 23 05 29

SECTION 23 05 48 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

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. Isolation pads.
   2. Isolation mounts.
   3. Elastomeric hangers.
   4. Spring hangers.
   5. Resilient pipe guides.
   6. Restrained vibration isolation roof-curb rails.
   7. Steel or inertia, vibration isolation equipment bases.

1.03 RELATED REQUIREMENTS:

A. SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT.

B. SECTION 23 21 13 - HYDRONIC PIPING.

1.04 REFERENCE STANDARDS:

A. Applicable Standards (Latest Edition):
   1. American Welding Society (AWS):
      a. AWS D1.1/D1.1M - Structural Welding Code - Steel.
   2. ASTM International (ASTM):
      a. ASTM A36/A36M - Specification for Carbon Structural Steel.
      b. ASTM A492 - Specification for Stainless Steel Rope Wire.
      c. ASTM A603 - Specification for Zinc-Coated Steel Structural Wire Rope.
      d. ASTM E488 - Test Methods for Strength of Anchors in Concrete and Masonry Elements.
   3. Code of Federal Regulations (CFR):
      a. 29 CFR - Labor, Chapter XVII - Occupational Safety and Health Administration, Department of Labor, Part 1910 - "Occupational Safety and Health Standards," Subpart A - "General," Section 1910.7 - "Definition and Requirements for a Nationally Recognized Testing Laboratory."
   4. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):
      a. MSS SP-127 - Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, and Application.
   5. Metal Framing Manufacturers Association (MFMA):
      a. MFMA-3 - Metal Framing Standards Publication.
   6. Structural Engineering Institute/American Society of Civil Engineers (SEI/ASCE):
      a. SEI/ASCE 7 - Minimum Design Loads for Buildings and Other Structures.

1.05 DEFINITIONS:

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.
C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.06 PERFORMANCE REQUIREMENTS:

A. Wind-Restraint Loading:
   1. Basic Wind Speed: 116 MPH Enclosed.
   2. Building Risk Category: III.
   3. Minimum 10 lb/sq. ft. (48.8 kg/sq. m) multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.
B. Seismic-Restraint Loading:
   1. Site Class as Defined in the IBC: B.
   2. Assigned Seismic Occupancy Category as Defined in the IBC: III.
      a. Component Importance Factor: 1.0.
      b. Component Response Modification Factor: 1.0.
      c. Component Amplification Factor: 1.0 .
   3. Design Spectral Response Acceleration at Short Periods (0.2 Second): 0.167g.
   4. Design Spectral Response Acceleration at 1-Second Period: 0.067g.
   5. Seismic Design Category: D.

1.07 SUBMITTALS:

A. Product Data: For the following:
   1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
B. Coordination Drawings: Show coordination of any bracing for HVAC piping and equipment with other systems and equipment in the vicinity.
C. Welding Procedure Specification (WPS) and Welder Performance Qualification Record (WPQR)
D. Field quality-control test reports.
E. The complete shop drawing submittal including Suspended Equipment details will be reviewed by both the mechanical and structural engineer.
F. Equipment Certification.
   1. Equipment manufacturer to provide certificate of compliance for 2018 IBC proving online capability for the project use group and seismic design category. Provide certifications for the following equipment: variable frequency controller, vibration isolators, air conditioning single zone units on emergency power, equipment support curbs, chillers, indoor custom air handlers, exhaust fans, and control panels. Equipment manufacturer certification to be based on three-dimensional shock testing or experience data as required by ASCE/SEI 7-05.
   2. The following equipment is considered rugged and does not require a certificate of compliance: pumps, valves, motors, air compressors, and underground tanks.

1.08 QUALITY ASSURANCE:

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Welding: Qualify welding procedures, welders, and welding operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.01 VIBRATION ISOLATORS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Amber/Booth Company, Inc.
   2. Kinetics Noise Control.
   3. Mason Industries.
   4. Vibration Eliminator Co., Inc.
   5. Vibration Mountings & Controls, Inc.

B. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
   1. Resilient Material: Oil- and water-resistant neoprene.

C. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
   1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
   2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

D. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
   1. Outside Spring Diameter: Not less than 80% of the compressed height of the spring at rated load.
   2. Minimum Additional Travel: 50% of the required deflection at rated load.
   3. Lateral Stiffness: More than 80% of rated vertical stiffness.
   4. Overload Capacity: Support 200% of rated load, fully compressed, without deformation or failure.
   5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch (6-mm) thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig (3,447 kPa).
   6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

E. Elastomeric Hangers: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.

F. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
   1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.

2. Outside Spring Diameter: Not less than 80% of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50% of the required deflection at rated load.
4. Lateral Stiffness: More than 80% of rated vertical stiffness.
5. Overload Capacity: Support 200% of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

G. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.
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% of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50% of the required deflection at rated load.
4. Lateral Stiffness: More than 80% of rated vertical stiffness.
5. Overload Capacity: Support 200% of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

H. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch (13-mm) thick 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 (3.45 MPa) and for equal resistance in all directions.

I. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch (13-mm) thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and re-insertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.02 VIBRATION ISOLATION EQUIPMENT BASES:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Amber/Booth Company, Inc.
2. Kinetics Noise Control.
3. Mason Industries.
4. Vibration Eliminator Co., Inc.
5. Vibration Mountings & Controls, Inc.

B. Steel Base: Factory-fabricated, welded, structural-steel bases and rails.

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.
   a. Include supports for suction and discharge elbows for pumps.
2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36 and ASTM A36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

2.03 FACTORY FINISHES:

A. Finish: Manufacturer's standard prime-coat finish ready for field 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 galvanized. Hot-dip galvanize metal components for exterior use.
   3. Baked enamel or powder coat for metal components on isolators for interior use.
   4. Color-code or otherwise mark vibration isolation and wind-control devices to indicate capacity range.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine areas and equipment to receive vibration isolation and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
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. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits.

3.03 VIBRATION-CONTROL INSTALLATION:

A. Comply with requirements in DIVISION 07 for installation of roof curbs, equipment supports, and roof penetrations.
B. Equipment Restraints:
   1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
C. Piping Restraints:
   1. Comply with requirements in MSS SP-127.
   2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
   3. Brace a change of direction longer than 12 feet (3.7 m).

D. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
E. 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.
F. 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.
G. Drilled-in Anchors:
    1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
    2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
    3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
    4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
    5. Set anchors to manufacturer's recommended torque, using a torque wrench.
    6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.04 FIELD QUALITY CONTROL:

3.05 ADJUSTING:
A. Adjust isolators after piping system is at operating weight.
B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
C. Adjust active height of spring isolators.

3.06 DEMONSTRATION:

3.07 HVAC VIBRATION-CONTROL DEVICE SCHEDULE:
A. Supported or Suspended Equipment:
    1. Equipment Location: All.
    2. Pads:
        a. Material: Neoprene.
        b. Thickness: Minimum ¾”
        c. Number of Pads: As Required.
    3. Component Importance Factor: 1.0.
    4. Component Response Modification Factor: 1.0.
    5. Component Amplification Factor: 1.0.

END OF SECTION 23 05 48

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SECTION 23 05 53 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

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:
   1. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.
   4. Duct labels.
   5. Stencils.
   6. Valve tags.
   7. Warning tags.

1.03 REFERENCE STANDARDS:

A. Applicable Standards (Latest Edition):
   1. ASME International (ASME):
      a. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.04 SUBMITTALS:

A. Product Data: For each type of product indicated.
B. Samples: For color, letter style, and graphic representation required for each identification material and device.
C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
D. Valve numbering scheme.
E. Valve Schedules: For each piping system to include in maintenance manuals.

1.05 COORDINATION:

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
B. Coordinate installation of identifying devices with locations of access panels and doors.
C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.01 EQUIPMENT LABELS:

1. .

B. Plastic Labels for Equipment:
   1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
   2. Letter Color: Yellow.
   3. Background Color: Black.
   4. Maximum Temperature: Able to withstand temperatures up to 160ºF (71ºC).
   5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inches (64 by 19 mm).

6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2 by 11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.02 WARNING SIGNS AND LABELS:

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick and having predrilled holes for attachment hardware.
B. Letter Color: Yellow.
C. Background Color: Black.
D. Maximum Temperature: Able to withstand temperatures up to 160ºF (71ºC).
E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inches (64 by 19 mm).
F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
G. Fasteners: Stainless-steel rivets or self-tapping screws.
H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.03 PIPE LABELS:

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
B. Pretensioned Pipe Labels: Pre-coiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches (38 mm) high.

2.04 DUCT LABELS:

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
B. Letter Color: Yellow.
C. Background Color: Black.
D. Maximum Temperature: Able to withstand temperatures up to 160ºF (71ºC).

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inches (64 by 19 mm).
F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
G. Fasteners: Stainless-steel rivets or self-tapping screws.
H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches (38 mm) high.

2.05 VALVE TAGS:
A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.
   1. Tag Material: Aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Fasteners: Brass wire-link chain.
B. Valve Schedules: For each piping system, on 8-1/2 by 11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), 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.
   1. Valve-tag schedule shall be included in operation and maintenance data.

2.06 WARNING TAGS:
A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
   1. Size: 3 by 5-1/4 inches minimum.
   2. Fasteners: Reinforced grommet and wire or string.
   3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
   4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.01 PREPARATION:
A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.02 EQUIPMENT LABEL INSTALLATION:
A. Install or permanently fasten labels on each major item of mechanical equipment.
B. Locate equipment labels where accessible and visible.

3.03 PIPE LABEL INSTALLATION:
A. Piping Color-Coding: Do not paint any mechanical systems.

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible 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 intervals of 50 ft. along each run. Reduce intervals to 25 ft in areas of congested piping and equipment.
   7. First and last label between walls to be located 25 ft. or closer after or before wall penetration.
   8. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Pipe Label Color Schedule:
   1. Chilled-Water Piping:
      a. Background Color: Blue.
      b. Letter Color & Flow Arrows: Yellow.
   2. Heating Water Piping:
      a. Background Color: Red.
      b. Letter Color & Flow Arrows: Yellow.
   3. Refrigerant Piping:
      a. Background Color: Black.
      b. Letter Color & Flow Arrows: Yellow.

3.04 DUCT LABEL INSTALLATION:

A. Install plastic-laminated duct labels with permanent adhesive on air ducts in the following color codes:
   1. Blue: For cold-air supply ducts.
   2. Yellow: For return air ducts.
   3. Green For general exhaust-, outside-, relief-, return-, and mixed-air ducts.
   4. ASME A13.1 Colors and Designs: For hazardous fume hood and vivarium exhaust.

B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 ft. in each space where ducts are exposed or concealed by removable ceiling system.

C. Provide radioactive waste placards at all locations accessible to hot waste, comply with ANSI Z535 requirements for signage and location requirements

3.05 VALVE-TAG INSTALLATION:

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
   1. Valve-Tag Size and Shape:
      a. 2 inches, round.
         (1) Refrigerant

(2) Heating Hot Water
(3) Gas

2. Valve-Tag Color:
   a. Natural for all
3. Letter Color:
   a. Black for all

3.06 WARNING-TAG INSTALLATION:

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 23 05 53

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SECTION 23 05 93 – CONTRACTOR SCOPE FOR OWNER SUPPLIED TAB

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 DESCRIPTION OF WORK:

A. This scope of services specifies the requirements and procedures for mechanical systems testing, adjusting, and balancing. Requirements include measurement and establishment of the fluid quantities of the mechanical systems as required to meet design specifications and recording and reporting the results. The test and balance work will be performed by the Owner's personnel. It is the Contractor's responsibility to assist as outlined below.

B. Test, adjust and balance the following mechanical systems which are shown in the construction documents.
   1. Supply air systems, all pressure ranges, including variable volume and constant volume systems.
   2. Return air systems.
   3. Exhaust air systems.
   4. Hydronic systems.
   5. Verify temperature control system operation.
   6. Cooling water systems (i.e. inline chilled water pumps, owner-furnished drycooler pumps).

C. C. The contractor's responsibilities are as follows:
   1. Notify the Owner's Representative fourteen (14) days prior to the schedule date for balancing the system.
   2. Schedule a 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 Contractor by the contract documents.
   3. Cooperate with the testing and balancing firm and shall make all necessary preparations for the TAB efforts.
   4. Complete the following work prior to requesting the TAB effort.
      a. Clean and flush all piping systems.
      b. Leak test and make tight all piping systems.
      c. Fill all piping systems with clean water.
      d. Clean and seal all ductwork systems.
      e. Service and tag all equipment.
      f. Set and align all motors and drives.
      g. Start up and prove all equipment and systems.
      h. Make preliminary settings on all control devices and have all systems operational.
      i. Operate all systems successfully for twenty-four (24) hours minimum.
   5. Lubricate all motors and bearings.
   6. Check fan belt tension.
   7. Check fan rotation.
   8. Patch insulation, ductwork and housing, using materials identical to those removed.
   9. Seal ducts and piping, and test for and repair leaks.
   10. Seal insulation to re-establish integrity of the vapor barrier.
   11. Attend a coordination meeting prior to the balancing of the system and a coordination meeting following the balancing of the system.
   12. Provide a complete set of as-built drawings prior to the TAB effort.

13. Provide craftsmen of the proper trade to work with the TAB firm to make adjustments and installation changes as required.
14. Change out fan sheaves when and if required by the TAB firm.
15. Dedicate the resources to accommodate all changes identified by the test and balance firm in a timely manner.
16. If a significant rebalance (Owner's determination) of the HVAC system is required due to the Contractor's failure to properly install and check out the HVAC system, the cost of rebalancing the system shall be borne by the Contractor.

1.03 PRE-BALANCING CONFERENCE:

A. Prior to beginning of the testing, adjusting and balancing procedures, a conference with the Owner's representative, Engineer and the Test and Balance Agency's representative will be held. The objective of the conference is final coordination and verification of system operation and readiness for testing, adjusting and balancing.

1.04 SEQUENCING AND SCHEDULING OF SERVICES:

A. Test, adjust and balance the air conditioning systems during summer season and heating systems during winter season. This includes at least a period of operation at outside conditions within 5°F wet bulb temperature of maximum summer design condition, and within 10°F dry bulb temperature of minimum winter design conditions. Take final temperature readings during seasonal operation.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 23 05 93

SECTION 23 07 13 – DUCT 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.

1.02 SUMMARY:

A. This SECTION includes requirements for insulating sheet metal ductwork.

1.03 RELATED REQUIREMENTS:

A. SECTION 23 0 716 - HVAC EQUIPMENT INSULATION.
B. SECTION 23 07 19 - HVAC PIPING INSULATION.
C. SECTION 23 31 13 - METAL DUCTS

1.04 REFERENCE STANDARDS:

A. Applicable Standards (Latest Edition):
   1. ASTM International (ASTM):
      a. ASTM A167 - Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
      b. ASTM A240/A240M - Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
      c. ASTM B209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
      d. ASTM B209M - Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
      e. ASTM C534 - Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
      f. ASTM C553 - Specification for Mineral Fiber Blanket and Thermal Insulation for Commercial and Industrial Applications.
      g. ASTM C612 - Specification for Mineral Fiber Block and Board Thermal Insulation.
      h. ASTM C795 - Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
      i. ASTM C871 - Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate, and Sodium Ions.
      j. ASTM C1136 - Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
      k. ASTM C1290 - Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
      l. ASTM C1393 – Specification for Perpendicularly Oriented Mineral Fiber Roll and Sheet Thermal Insulation for Pipes and Tanks
      m. ASTM D1644 - Test Methods for Nonvolatile Content of Varnishes.
      n. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.
      o. ASTM E96/E96M - Test Methods for Water Vapor Transmission of Materials.
      p. ASTM F1249 - Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor.
   2. California Department of Health Services:

a. Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, 2004.

3. Code of Federal Regulations (CFR):
   a. 40 CFR - Protection of Environment, Chapter I - Environmental Protection Agency, Part 59 -"National Volatile Organic Compound Emission Standards for Consumer and Commercial Products," Subpart D - "National Volatile Organic Compound Emission Standards for Architectural Coatings," 2007.
4. NFPA:
   a. NFPA 90A - Installation of Air-Conditioning and Ventilating Systems.
   b. NFPA 90B - Installation of Warm Air Heating and Air-Conditioning Systems.

1.05 SUBMITTALS:

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and field-applied jackets (if any).

B. Shop Drawings: Include details, and attachments to other work. Submit completed plates for pertinent details from the National Commercial and Industrial Insulation Standards manual as shop drawings.
   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail application of field-applied jackets.

C. Qualification Data: For qualified Installer.

D. Field quality-control reports.

1.06 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. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

C. All ducts and fittings (related to Coatings for Fire Rated Ductwork System) shall be manufactured by the approved fire resistive ductwork manufacturer whose primary business experience is the manufacture of fire resistive ductwork and fittings. The Contractor shall have adequate experience of building fire resistive ductwork of the types required for this project as well as successful experience with projects of similar scope.

D. Products shall not contain formaldehyde, asbestos, lead, mercury, mercury compounds, or poly-brominated diphenyl ether fire retardants.

1.07 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.

B. Protect Fire Resistive Duct – ductwork, accessories and purchased products shall be protected from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings. Store ductwork indoors and protect from exposure to weather during storage and post installation and protect from damage from other trades. Where the product can be exposed to winter weather conditions, the product must be protected to prevent exposure to moisture. Where necessary to store outside for a short time period store above grade on wooden pallets and enclose with secured waterproof wrapping.

1.08 COORDINATION:

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT.

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing 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.

1.09 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 INSULATION MATERIALS:

A. Comply with requirements in "Duct Insulation Schedule, General," for where insulating materials shall be applied.

B. Products shall not contain formaldehyde, 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. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type III and ASTM C1290, Type II, with factory-applied FSK or PSK jacket per insulation schedule. Minimum density is 1 lb/ft^3. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. CertainTeed Corp.; SoftTouch Duct Wrap.
   b. Johns Manville; Microlite.
   c. Knauf Insulation; Atmosphere Duct Wrap w/ECOSE.
   d. Manson Insulation; Alley Wrap B w/ECOSE.
   e. Owens Corning; SOFTR All-Service Duct Wrap.

G. High-Temperature Fibrous Blanket Insulation: Comply with ASTM E2336 for grease duct applications. Factory-applied fiberglass-reinforced aluminized polyester foil jacket. Minimum density is 6 lb/ft^3.
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. 3M; Fire Barrier Duct Wrap 615+.
      b. Unifrax; FyreWrap elited 1.5.
      c. Morgan Advanced Materials; FireMaster Fast Wrap XL.
      d. Or approved equal.

H. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type IA or Type IB. Minimum density is 3 lb/ft^3. For duct and plenum applications, provide insulation with FSK or ASJ factory-applied jacket.
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. CertainTeed Corp.; SoftTouch Duct Wrap.
      b. Johns Manville; Microlite.
      c. Knauf Insulation; Friendly Feel Duct Wrap.
      d. Owens Corning; SOFTR All-Service Duct Wrap.

I. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type IA or Type IB. Minimum density is 3 lb/ft^3. For duct and plenum applications, provide insulation with FSK or ASJ factory-applied jacket.
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. CertainTeed Corp.; Certa Pro.
      b. Knauf Insulation; Earthwool Insulation Board w/ECOSE.
      c. Manson Insulation AK Board w/ECOSE.
      d. Owens Corning; Fiberglas 703.

2.02 ADHESIVES:

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. Aeroflex USA, Inc.; Aeroseal.
      b. Armacell, LLC; Armaflex 520 Adhesive.
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
      d. K-Flex USA; R-373 Contact Adhesive.
   2. 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).
   3. 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."

C. Mineral-Fiber Board or Blanket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. 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."

D. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. Products: Subject to compliance with requirements, provide products by one of the following:
a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
d. Mon-Eco Industries, Inc.; 22-25.
2. 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).
3. 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."

2.03 MASTICS:

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
1. Products: Subject to compliance with requirements, provide products by one of the following:
a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
b. Vimasco Corporation; 749.
2. Water-Vapor Permeance: ASTM E96/E96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
3. Service Temperature Range: -20 to +180ºF (-29 to +82ºC).
4. Solids Content: ASTM D1644, 58% by volume and 70% by weight.
5. Color: White.

2.04 SEALANTS:

A. FSK and Metal Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
b. Eagle Bridges - Marathon Industries; 405.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: -40 to +250ºF (-40 to +121ºC).
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants 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. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide products by the following:
a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: -40 to +250ºF (-40 to +121ºC).
5. Color: White.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants 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."

2.05 FACTORY-APPLIED JACKETS:

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, Kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
2. ASJ+: Polymer-film, white kraft paper, fiberglass-scrim reinforced, with aluminum foil backing, complying with ASTM C1136, Type I, II, III, IV, VII, VIII, X.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with Kraft-paper backing; complying with ASTM C1136, Type II.
4. PSK Jacket: Polypropylene, fiberglass-scrim reinforced with Kraft-paper backing, complying with ASTM C1136, Type II.

2.06 FIELD-APPLIED JACKETS OR COATINGS:

A. Metal Jacket:
1. Products: Subject to compliance with requirements, provide products by one of the following:
a. Childers Brand, a business of Johns Manville; Metal Jacketing Systems.
b. Ideal Products Metal Jacketing Systems.
c. RPR Products, Inc.; Insul-Mate.

2. Aluminum Jacket: Comply with ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.
   a. Finish and thickness are indicated in field-applied jacket schedules.
   b. Moisture Barrier for Indoor Applications: 2.5-mil thick polysurlyn.
   c. Moisture Barrier for Outdoor Applications: 2.5-mil thick polysurlyn.

B. Coatings for Fire Rated Ductwork System: Apply fire rated enclosures to protect the building from both a fire outside the shaft from entering into the shaft and from a fire inside a shaft from exiting the shaft. The coating for fire rated ductwork system shall illuminate the risk of spreading a fire within a structure. With the use of the Coating System shall provide for a Fire Rated Duct Systems (shall be 2-Hour Duct Type B Fire Rated Duct) shall provide for the same degree of fire rating as provided by walls or floors in the compartment. Ductwork shall be fabricated in accordance to the relevant Fire Resistive Duct manufacturer's construction standards. All details shall be obtained from manufacturer such that the contractor has absolute clarity and single source responsibility with the manufacturer of this system. All Fire Resistive Duct shall be Type B tested to fire inside and fire outside in accordance with ISO 6944. ASTM E2816 equivalent shall be Condition C or Condition D (Condition A or Condition B is not acceptable). Provide a complete hourly rated fire resistive hanger and support system as per manufacturer's requirements.
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. Flamebar as supplied by Conquest-Firespray LLC (Flamebar™ Fire-Rated Shaft Systems)
      b. Owner approved equal

2.07 TAPES:

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. ABI, Ideal Tape Division; 428 AWF ASJ.
      b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
      c. Compac Corporation; 104 and 105.
      d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
   2. Width: 3 inches (75 mm).
   3. Thickness: 11.5 mils (0.29 mm).
   4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
   5. Elongation: 2%.
   6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
   7. 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.
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. ABI, Ideal Tape Division; 491 AWF FSK.
      b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
      c. Compac Corporation; 110 and 111.
      d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches (75 mm).
3. Thickness: 6.5 mils (0.16 mm).
4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
5. Elongation: 2%.
6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
8. Products: Subject to compliance with requirements, provide products by one of the following:
   a. ABI, Ideal Tape Division; 370 White PVC tape.
   b. Compac Corporation; 130.
   c. Venture Tape; 1506 CW NS.
9. Width: 2 inches (50 mm).
10. Thickness: 6 mils (0.15 mm).
11. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
12. Elongation: 500%.
13. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. ABI, Ideal Tape Division; 488 AWF.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   c. Compac Corporation; 120.
   d. Venture Tape; 3520 CW.
2. Width: 2 inches (50 mm).
3. Thickness: 3.7 mils (0.093 mm).
4. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
5. Elongation: 5%.
6. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

2.08 SECUREMENTS:

A. Bands:
1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
2. Stainless Steel: ASTM A167 or ASTM A240/A240M, Type 304; 0.015 inch (0.38 mm) thick, 1/2 inch (13 mm) wide with wing seal or closed seal.
3. Aluminum: ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005; Temper H 14, 0.020 inch (0.51 mm) thick, 1/2 inch (13 mm) wide with wing seal or closed seal.

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 diameter shank, length to suit depth of insulation indicated.
   a. Products: Subject to compliance with requirements, provide products by one of the following:
      (1) AGM Industries, Inc.; CWP-1.
      (2) GEMCO; CD.
      (3) Midwest Fasteners, Inc.; CD.
      (4) Nelson Stud Welding; TPA, TPC, and TPS.

C. Staples: Outward-clinching insulation staples, nominal 1/2-inch (13-mm) wide, stainless steel or Monel.

2.09 CORNER ANGLES:

A. Aluminum Corner Angles: 0.040 inch (1.0 mm) thick, minimum 1- by 1-inch (25- by 25-mm) aluminum according to ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
   1. Verify that systems to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.03 GENERAL INSTALLATION REQUIREMENTS:

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct 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. 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.

H. Install insulation with least number of joints practical.

I. 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.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.

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 1-1/2 inches (38 mm). Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) o.c.
   a. For below ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75% of its nominal thickness. Careful attention to be given to tension of blanket as not to exceed 75% untensioned thickness when covering edges.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Install corner angles at all square and rectangular ducts within 6 feet off floor level.

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.

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 up to 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: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches (50 mm).
   1. Comply with requirements in DIVISION 07.

E. Insulation Installation at Floor Penetrations:
   1. Duct: 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. Seal penetrations through fire-rated assemblies. Comply with requirements in DIVISION 07.

3.05 INSTALLATION OF MINERAL-FIBER INSULATION:

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area.
   2. Apply adhesive to all surfaces of fittings and transitions.
   3. Do not stretch duct wrap insulation around ductwork!
   4. Install capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
      a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
      b. On duct sides with dimensions larger than 18 inches (450 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.
      c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
      d. Install pins on horizontal ducts at the bottom and sides of the duct at 18 inch intervals.
      e. Duct wrap shall be pinned on vertical ducts to prevent sagging
      f. Do not compress insulation more than 25% of labeled thickness during installation.
      g. Impale insulation over pins and attach speed washers.
      h. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
   5. For SA, RA and EA ducts and plenums, 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 one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1-inch (25-mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
      a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
      b. Install vapor stops for ductwork and plenums operating below 50ºF (10ºC) 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 two times the insulation thickness, but not less than 3 inches (75 mm).
   6. 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.

7. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
8. 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.
9. Provide neatly beveled edge at interruptions of insulation. Coat bare edges of insulation with mastic to prevent delamination.
10. Maintain integrity of vapor barrier on insulation and prevent from puncture and other damage.

B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area.
2. Apply adhesive to all surfaces of fittings and transitions.
3. 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:
    a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16-inches (400-mm) o.c.
    b. On duct sides with dimensions larger than 18 inches (450 mm), space 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.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not over compress insulation during installation.
    e. 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.
4. For SA, RA, EA ducts and plenums, 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 one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1-inch (25-mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50ºF (10ºC) 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 two times the insulation thickness, but not less than 3 inches (75 mm).
5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. 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 FIELD-APPLIED JACKET INSTALLATION:

A. 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.

3.07 COATINGS FOR FIRE RATED DUCTWORK SYSTEM INSTALLATION:

A. Install coating on ductwork fire rated ductwork coating system per manufacturer's installation instruction and design guidelines. Install field applied coating at each field joint to maintain the ceramic coating throughout the full length of routing through the chase.
B. Duct supports and ductwork hangars are an integral part of the fire resistive duct system and as such the design of the hangar system shall be designed by the fire resistive duct manufacturer.
C. The use of straps or cable type hangars shall not be allowed on any fire resistive duct system.
D. The maximum hanger spacing shall be 48" on centers, and additionally on each side of an elbow or change-in-direction fitting.

3.08 FINISHES:

A. Insulation with ASJ: Paint jacket with paint system identified below and as specified in DIVISION 09 Painting Sections.
B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
D. Do not field paint aluminum or stainless-steel jackets.

3.09 DUCT INSULATION SCHEDULE, GENERAL:

DUCT LOCATION AND SERVICE	INSULATION TYPE	JACKET	MIN. THICKNESS (IN.) OR ASHRAE
EXTERIOR EXHAUST WITHOUT ENERGY RECOVERY	FLEXIBLE ELASTOMERIC	ACRYLIC PAINT	3/4”
SUPPLY DUCT IN VERTICAL CHASE OR ABOVE LAY-IN CEILING	MINERAL FIBER BLANKET	FSK	1.5
SUPPLY DUCT IN UNCONDITIONED SPACE LIKE INTERSTITIAL SPACE OR NON-RETURN AIR PLENUM	MINERAL FIBER BLANKET	FSK	1.5
SUPPLY, RETURN, AIR DUCTS IN MECHANICAL SPACES. OUTDOOR AIR DUCTS IN MECHANICAL SPACES	MINERAL FIBER BOARD	FSK	2” -- SUPPLY 1” – RETURN, O.A.
COMPLETELY CONCEALED AND INACCESSIBLE SUPPLY, RETURN, OUTDOOR, AIR DUCTS	MINERAL FIBER BLANKET	FSK	2
RETURN DUCT IN RETURN AIR PLENUM	NONE REQUIRED	---	---
RETURN DUCT IN UNCONDITIONED SPACE	MINERAL FIBER BLANKET	FSK	1
DUCTWORK EXPOSED IN FINISHED SPACE TO BE PAINED	MINERAL FIBER BLANKET	FSK	1.5
DUCTWORK EXPOSED IN FINISHED SPACE – UNPAINTED	DOUBLE WALL SPIRAL	----	----
ALL ROUND DUCTWORK IN MECHANICAL ROOMS (EXHAUST DUCT NOT REQUIRED TO BE INSULATED)	MINERAL FIBER SEMI RIGID	FSK	2

END OF SECTION 23 07 13

SECTION 23 07 16 – HVAC EQUIPMENT 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.

1.02 SUMMARY:

1. Chilled-water pumps.
2. Heating, hot-water pumps.
3. U-bends of air terminal reheat coils

1.03 RELATED REQUIREMENTS:

A. SECTION 23 07 13 - DUCT INSULATION.
B. SECTION 23 07 19 - HVAC PIPING INSULATION.

1.04 REFERENCE STANDARDS:

A. Applicable Standards (Latest Edition):
   1. ASTM International (ASTM):
      a. ASTM A167 - Specification for Stainless- and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
      b. ASTM A240/A240M - Specification for Chromium and Chromium-Nickel Stainless-Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
      c. ASTM B209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
      d. ASTM B209M - Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
      e. ASTM C195 - Specification for Mineral Fiber Thermal Insulating Cement.
      f. ASTM C196 - Specification for Expanded or Exfoliated Vermiculite Thermal Insulating Cement.
      g. ASTM C449 - Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
      h. ASTM C450 - Practice for Fabrication of Thermal Insulation Fitting Covers for NPS Piping, and Vessel Lagging.
      i. ASTM C533 - Specification for Calcium Silicate Block and Pipe Thermal Insulation.
      j. ASTM C534 - Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
      k. ASTM C547 - Specification for Mineral Fiber Pipe Insulation.
      l. ASTM C552 - Specification for Cellular Glass Thermal Insulation.
      m. ASTM C553 - Specification for Mineral-Fiber Blanket and Thermal Insulation for Commercial and Industrial Applications.
      n. ASTM C585 - Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
      o. ASTM C612 - Specification for Mineral Fiber Block and Board Thermal Insulation.
      p. ASTM C656 - Specification for Structural Insulating Board, Calcium Silicate.
      q. ASTM C795 - Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

r. ASTM C871 - Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate, and Sodium Ions.
s. ASTM C921 - Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
t. ASTM C1136 - Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
u. ASTM C1290 - Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
v. ASTM C1393 - Specification for Perpendicularly Oriented Mineral Fiber Roll and Sheet Thermal Insulation for Pipes and Tanks.
w. ASTM D1644 - Test Methods for Nonvolatile Content of Varnishes.
x. ASTM D1784 - Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
y. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.
z. ASTM E96/E96M - Test Methods for Water Vapor Transmission of Materials.
aa. ASTM F1249 - Test Method for Water Vapor Transmission Rate through Plastic Film and Sheeting Using a Modulated Infrared Sensor.

2. California Department of Health Services.
   a. Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, 2004.
3. Code of Federal Regulations (CFR):
   a. 40 CFR - Protection of Environment, Chapter I - Environmental Protection Agency, Part 59 - "National Volatile Organic Compound Emission Standards for Consumer and Commercial Products," Subpart D - "National Volatile Organic Compound Emission Standards for Architectural Coatings," 2007.
4. Military Specifications (MIL):
   a. MIL-A-24179A - Adhesive, Flexible Unicellular-Plastic Thermal Insulation.
   b. MIL-A-3316C - Adhesives, Fire-Resistant, Thermal Insulation.
   c. MIL-C-20079H - Cloth, Glass; Tape, Textile Glass and Thread, Glass and Wire-Reinforced Glass.
   d. MIL-PRF-19565C - Coating Compounds, Thermal Insulation, Fire- and Water-Resistant, Vapor Barrier.
5. NFPA:
   a. NFPA 90A - Installation of Air-Conditioning and Ventilating Systems.
   b. NFPA 90B - Installation of Warm Air Heating and Air-Conditioning Systems.

1.05 SUBMITTALS:

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).
B. Shop Drawings: Include details, and attachments to other work.
   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail attachment and covering of heat tracing inside insulation.
   3. Detail application of field-applied jackets.
C. Field quality control reports.

1.06 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. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory-label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.07 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.

1.08 COORDINATION:

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT.

B. Coordinate clearance requirements with equipment Installer for equipment insulation application.

C. Coordinate installation and testing of heat tracing.

1.09 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 INSULATION MATERIALS:

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.

B. 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.

C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.

D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

E. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. Pittsburgh Corning Corporation; Foamglass.

2. Block Insulation: ASTM C552, Type I.
3. Special-Shaped Insulation: ASTM C552, Type III.
4. Board Insulation: ASTM C552, Type IV.
5. Factory-fabricate shapes according to ASTM C450 and ASTM C585.

F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534, Type I for tubular materials and Type II for sheet materials.
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. Aeroflex USA, Inc.; Aerocel.
      b. Armacell, LLC; AP Armaflex.
      c. K-Flex USA; Insul-Sheet and K-FLEX LS.

G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, :
      a. CertainTeed Corp.; SoftTouch Duct Wrap.
      b. Johns Manville; Microlite.
      c. Knauf Insulation; Friendly Feel Duct Wrap.
      d. Manson Insulation, Inc.; Alley Wrap.
      e. Owens Corning; SOFTR All-Service Duct Wrap.

H. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type V, without factory-applied jacket.
   1. Products: Subject to compliance with requirements:
      a. Industrial Insulation Group (IIG); MinWool-1200 Flexible Batt.
      b. Johns Manville; HTB 26 Spin-Glas.
      c. Roxul, Inc.; Roxul RW.

I. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type IA or Type IB. Provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements:
      a. CertainTeed Corp.; CertaPro Commercial Board.
      b. Fibrex Insulations, Inc.; FBX.
      c. Johns Manville; 800 Series Spin-Glas.
      d. Knauf Insulation; Insulation Board.
      e. Manson Insulation, Inc.; AK Board.
      f. Owens Corning; Fiberglas 700 Series.

J. High-Temperature, Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type III, without factory-applied jacket.
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. Fibrex Insulations, Inc.; FBX.
      b. Industrial Insulation Group (IIG); MinWool-1200 Industrial Board.
      c. Rock Wool; Delta Board.
      d. Roxul, Inc.; RHT and RockBoard.
      e. Thermafiber, Inc.; Thermafiber Industrial Felt.

K. Mineral-Fiber, Preformed Pipe Insulation:
   1. Products: Subject to compliance with requirements, provide products by one of the following:

a. Fibrex Insulations, Inc.; Coreplus 1200.
b. Johns Manville; Micro-Lok.
c. Knauf Insulation; 1,000-Degree Pipe Insulation.
d. Manson Insulation, Inc.; Alley-K.
e. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850ºF (454ºC) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

L. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C612, Type IB. Nominal density is 2.5 lb./ft.³ (40 kg/m³) or more. Thermal conductivity (k value) at 100ºF (55ºC) is 0.29 Btu by inch/hr. by ft.² by ºF (0.042 W/m by K) or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements provide products by one of the following:
a. CertainTeed Corp.; CrimpWrap.
b. Johns Manville; MicroFlex.
c. Knauf Insulation; Pipe and Tank Insulation.
d. Manson Insulation, Inc.; AK Flex.
e. Owens Corning; Fiberglas Pipe and Tank Insulation.

M. Preformed Thermal Insulation Jacket Systems: Needled glass fiber, 1.5” thick rated to 1000°F. Silicone jacket material for hot side and cold side of assembly. Nylon holding straps with “D” rings and Kevlar thread. Minimum 4 stiches per inch with Kevlar thread capable of withstanding minimum 300°F temperatures. Hog rings, staples and wire are not acceptable methods of closure. Jackets to be fastened with combination of “D” rings and hook/loop fasteners. All preformed thermal insulation jacket systems are to be custom fit to application using integral insulation and jacket system fabricated to be fully removable and reassembled multiple times during lifespan.

2.02 INSULATING CEMENTS:

A. Mineral-Fiber Insulating Cement: Comply with ASTM C195.
1. Products: Subject to compliance with requirements, provide products by one of the following:
a. Ramco Insulation, Inc.; Super-Stik.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.
1. Products: Subject to compliance with requirements, provide products by one of the following:
a. Ramco Insulation, Inc.; Thermokote V.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.
1. Products: Subject to compliance with requirements, provide products by one of the following:
a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

2.03 ADHESIVES:

A. Military Specification in this article was the only standard available when this SECTION was written. MIL-A-3316C was last updated in October 1987.

B. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

C. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of -100 to +200ºF (-73 to +93ºC).
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-84.
   2. 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).
   3. 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."

D. Flexible Elastomeric-Adhesive: Comply with MIL-A-24179A, Type II, Class I.
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. Aeroflex USA, Inc.; Aeroseal.
      b. Armacell, LLC; Armaflex 520 Adhesive.
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
      d. K-Flex USA; R-373 Contact Adhesive.
   2. 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).
   3. 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."

E. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
      b. Eagle Bridges - Marathon Industries; 225.
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
      d. Mon-Eco Industries, Inc.; 22-25.
   2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   3. 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."

F. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
   1. Products: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
d. Mon-Eco Industries, Inc.; 22-25.

2. 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).
3. 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."

2.04 MASTICS:

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
1. Products: Subject to compliance with requirements, provide products by one of the following:
a. Foster Brand, Specialty Construction Brands, Inc., a business of H .B. Fuller Company; 30-80/30-90.
b. Vimasco Corporation; 749.
2. Water-Vapor Permeance: ASTM E96/E96M, Procedure B, 0.013 perm (0.009 metric perm) at 43 mil (1.09 mm) dry film thick +180ºF (-29 to +82ºC).
3. Solids Content: ASTM D1644, 58% by volume and 70% by weight.
4. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.
1. Products: Subject to compliance with requirements, provide products by one of the following:
a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-30.
b. Eagle Bridges - Marathon Industries; 501.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-35.
d. Mon-Eco Industries, Inc.; 55-10.
2. Water-Vapor Permeance: ASTM F1249, 0.05 perm (0.03 metric perm) at 35 mil (0.9 mm) dry film thickness.
3. Service Temperature Range: 0 to 180ºF (-18 to +82ºC).
4. Solids Content: ASTM D1644, 44% by volume and 62% by weight.
5. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
1. Products: Subject to compliance with requirements, provide products by one of the following:
a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Encacel.
b. Eagle Bridges - Marathon Industries; 570.

c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 60-95/60-96.

2. Water-Vapor Permeance: ASTM F1249, 0.05 perm (0.033 metric perm) at 30 mil (0.8 mm) dry film thickness.
3. Service Temperature Range: -50 to +220ºF (-46 to +104ºC).
4. Solids Content: ASTM D1644, 33% by volume and 46% by weight.
5. Color: White.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
   b. Eagle Bridges - Marathon Industries; 550.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
   d. Mon-Eco Industries, Inc.; 55-50.
   e. Vimasco Corporation; WC-1/WC-5.
2. Water-Vapor Permeance: ASTM F1249, 1.8 perms (1.2 metric perms) at 0.0625 inch (1.6 mm) dry film thickness.
3. Service Temperature Range: - 20 to +180ºF (-29 to +82ºC).
4. Solids Content: 60% by volume and 66% by weight.
5. Color: White.

2.05 LAGGING ADHESIVES:

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Products: Subject to compliance with requirements, provide products by one of the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
   b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
   c. Vimasco Corporation; 713 and 714.
3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment insulation.
4. Service Temperature Range: 0 to +180ºF (-18 to +82ºC).
5. Color: White.

2.06 SEALANTS:

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass Products: Subject to compliance with requirements, provide products by one of the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
   b. Eagle Bridges - Marathon Industries; 405.

c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
d. Mon-Eco Industries, Inc.; 44-05.
e. Pittsburgh Corning Corporation; Pittseal 444.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: -100 to +300ºF (-73 to +149ºC).
5. Color: White or gray.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants 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. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
   b. Eagle Bridges - Marathon Industries; 405.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
   d. Mon-Eco Industries, Inc.; 44-05.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: -40 to +250ºF (-40 to +121ºC).
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants 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."

C. ASJ Flashing Sealants:

1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: -40 to +250ºF (-40 to +121ºC).
5. Color: White.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants 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."

2.07 FACTORY-APPLIED JACKETS:

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, Kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
   2. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with Kraft-paper backing; complying with ASTM C1136, Type II.

2.08 FIELD-APPLIED FABRIC-REINFORCING MESH:

A. Woven Glass-Fiber Fabric: Approximately 6 oz./yd.^{2} (203 g/m^2) with a thread count of 5 strands by 5 strands/in.^{2} (2 strands by 2 strands/mm^2) for covering equipment.
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Chil-Glas No. 5.

B. Woven Polyester Fabric: Approximately 1 oz./yd.^{2} (34 g/m^2) with a thread count of 10 strands by 10 strands/inch^2 (4 strands by 4 strands/mm^2), in a Leno weave, for equipment.
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Mast-A-Fab.
      b. Vimasco Corporation; Elastafab 894.

2.09 FIELD-APPLIED CLOTHS:

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./yd.^{2} (271 g/m^2).
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

2.10 FIELD-APPLIED JACKETS:

A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with Kraft-paper backing.
   1. Aluminum Jacket: Comply with ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.
      a. Sheet and roll stock ready for shop or field sizing.
      b. Finish and thickness are indicated in field-applied jacket schedules.
      c. Moisture Barrier for Indoor Applications: 1-mil (0.025-mm) thick, heat-bonded polyethylene and Kraft paper.
      d. Moisture Barrier for Outdoor Applications: 3-mil.
      e. Factory-Fabricated Fitting Covers:
         (1) Same material, finish, and thickness as jacket.
         (2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
         (3) Tee covers.
         (4) Flange and union covers.
         (5) End caps.
         (6) Beveled collars.

(7) Valve covers.
(8) Field-fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.11 TAPES:

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
1. Products: Subject to compliance with requirements, provide products by one of the following:
a. ABI, Ideal Tape Division; 428 AWF ASJ.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
c. Compac Corporation; 104 and 105.
d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
2. Width: 3 inches (75 mm).
3. Thickness: 11.5 mils (0.29 mm).
4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
5. Elongation: 2%.
6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
7. 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.
1. Products: Subject to compliance with requirements, provide products by one of the following:
a. ABI, Ideal Tape Division; 491 AWF FSK.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
c. Compac Corporation; 110 and 111.
d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
2. Width: 3 inches (75 mm).
3. Thickness: 6.5 mils (0.16 mm).
4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
5. Elongation: 2%.
6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide products by one of the following:
a. ABI, Ideal Tape Division; 488 AWF.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
c. Compac Corporation; 120.
d. Venture Tape; 3520 CW.
2. Width: 2 inches (50 mm).
3. Thickness: 3.7 mils (0.093 mm).
4. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
5. Elongation: 5%.
6. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

2.12 SECUREMENTS:

A. Bands:

1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. ITW Insulation Systems; Gerrard Strapping and Seals.
   b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
2. Stainless Steel: ASTM A167 or ASTM A240/A240M, Type 304; 0.015-inch (0.38-mm) thick, 1/2 inch wide with wing seal.
3. Aluminum: ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005; Temper H 14, 0.020 inch (0.51 mm) thick, 3/4 inch (19 mm) wide with wing seal.

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 diameter shank, length to suit depth of insulation indicated.
   a. Products: Subject to compliance with requirements, provide products by one of the following:
      (1) AGM Industries, Inc.; CWP-1.
      (2) GEMCO; CD.
      (3) Midwest Fasteners, Inc.; CD.
      (4) Nelson Stud Welding; TPA, TPC, and TPS.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38 mm) galvanized carbon-steel washer.
   a. Products: Subject to compliance with requirements, provide products by one of the following:
      (1) AGM Industries, Inc.; CHP-1.
      (2) GEMCO; Cupped Head Weld Pin.
      (3) Midwest Fasteners, Inc.; Cupped Head.
      (4) Nelson Stud Welding; CHP.
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.
   a. Products: Subject to compliance with requirements, provide products by one of the following:
      (1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
      (2) GEMCO; Perforated Base.
      (3) Midwest Fasteners, Inc.; Spindle.
   b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
   c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch (2.6-mm) diameter shank, length to suit depth of insulation indicated.
   d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
   a. Products: Subject to compliance with requirements, provide products by one of the following:
      (1) GEMCO; Nylon Hangers.

(2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.

b. Baseplate: Perforated, nylon sheet, 0.030 inch (0.76 mm) thick by 1-1/2 inches (38 mm) in diameter.

c. Spindle: Nylon, 0.106-inch (2.6-mm) diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches (63 mm).

d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Self-Sticking-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.

a. Products: Subject to compliance with requirements, provide products by one of the following:

(1) AGM Industries, Inc.; Tactoo Self-Adhering Insul-Hangers, Series.

(2) GEMCO; Peel & Press.

(3) Midwest Fasteners, Inc.; Self Stick.

b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.

c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch (2.6-mm) diameter shank, length to suit depth of insulation indicated.

d. Adhesive-backed base with a peel-off protective cover.

6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch (0.41-mm) thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

a. Products: Subject to compliance with requirements, provide products by one of the following:

(1) AGM Industries, Inc.; RC-150.

(2) GEMCO; R-150.

(3) Midwest Fasteners, Inc.; WA-150.

(4) Nelson Stud Welding; Speed Clips.

b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch (0.41-mm) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38-mm) in diameter.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

(1) GEMCO.

(2) Midwest Fasteners, Inc.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch (19-mm) wide, stainless steel or Monel.

D. Wire: 0.062-inch (1.6-mm) soft-annealed, stainless steel.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. C & F Wire.

2.13 CORNER ANGLES:

A. Aluminum Corner Angles: 0.040-inch thick, minimum 1 by 1 inch (25 by 25 mm), aluminum according to ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
   1. Verify that systems and equipment to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:

A. 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 GENERAL INSTALLATION REQUIREMENTS:

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment 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. 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.

H. Install insulation with least number of joints practical.

I. 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 insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   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 1-1/2 inches (38 mm). Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
      a. For below ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.

L. Cut insulation in a manner to avoid compressing insulation more than 75% of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

O. For above ambient services, do not install insulation to the following:
   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.
   4. Shell Flange
   5. Head Flange
   6. Manholes.
   7. Handholes.
   8. Cleanouts.

3.04 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION:

A. Mineral-Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 % coverage of tank and vessel surfaces.
   2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
   3. Protect exposed corners with secured corner angles.
   4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
      a. Do not weld anchor pins to ASME-labeled pressure vessels.
      b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
      c. On tanks and vessels, maximum anchor-pin spacing is 3 inches (75 mm) from insulation end joints, and 16 inches (400 mm) o.c. in both directions.
      d. Do not overcompress insulation during installation.

e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
f. Impale insulation over anchor pins and attach speed washers.
g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches (150 mm) from each end. Install wire or cable between two circumferential girdles 12 inches (300 mm) o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches (1200 mm) o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches (75 mm).
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
1. Apply 100% coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:
1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch (150-mm) centers, starting at corners. Install 3/8-inch (10-mm) diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. Fabricate boxes from aluminum, at least 0.040 inch thick.
3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.05 FIELD-APPLIED JACKET INSTALLATION:

A. 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.

B. Where FSK jackets are indicated, install as follows:
1. Draw jacket material smooth and tight.

2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch (75-mm) wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

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.

3.06 FINISHES:

A. Equipment 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.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field-paint aluminum or stainless-steel jackets.

3.07 FIELD QUALITY CONTROL:

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections: Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.08 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 that is not factory insulated.
1. Flexible Elastomeric: 1 inch thick.

C. Heat-exchanger (water-to-water for cooling service) insulation shall be one of the following:
1. Flexible Elastomeric: 1 inch thick.

D. Heat-exchanger (water-to-water for heating service) insulation shall be one of the following:

E. Steam-to-hot-water converter insulation shall be one of the following:
1. Mineral-Fiber: 3 inches thick.

F. Chilled-water pump insulation shall be one of the following:
1. Flexible Elastomeric: 1 inch thick.

G. Heating-hot-water pump insulation shall be one of the following:
1. None

H. Steam condensate pump insulation shall be one of the following:
   1. Mineral-Fiber Board: 2 inches thick and 3 lb./ft.³ nominal density.
   2. Mineral-Fiber Pipe and Tank: 2 inches thick
I. Steam powered condensate pumping trap:
   1. Preformed Thermal Insulation Jacket Systems
J. Steam pressure reducing stations:
   1. Preformed Thermal Insulation Jacket Systems
K. Chilled-water expansion/compression tank insulation shall be one of the following:
   1. None.
L. Heating-hot-water expansion/compression tank insulation shall be one of the following:
   1. None.
M. Heat-recovery expansion/compression tank insulation shall be one of the following:
   1. None
N. Chilled-water air-separator insulation shall be one of the following:
   1. Flexible Elastomeric: 1 inch thick.
O. Heating-hot-water air-separator insulation shall be one of the following:
   1. Mineral-Fiber : 1.5" thick
P. Heat-recovery air-separator insulation shall be one of the following:
   1. Flexible Elastomeric: 1 inch thick.
   2. Steam condensate tank and receiver insulation shall be one of the following:
   3. Mineral-Fiber Board: 2 inches thick and 3 lb./ft.³ nominal density.
   4. Mineral-Fiber Pipe and Tank: 2 inches thick.
Q. U-bends and any uninsulated portion of the reheat coil casings of air terminal reheat coils:
   1. Mineral-Fiber blanket: 1" thick

3.09 INDOOR, FIELD-APPLIED JACKET SCHEDULE:

A. Install jacket over insulation material. For insulation with factory-applied jacket. For equipment provided with factory applied jacket, no field-applied jacket over the factory-applied jacket is required to be installed.
B. If more than one material is listed, selection from materials listed is Contractor's option.
C. Equipment, Concealed:
   1. Aluminum Stucco Embossed: 0.016 inch thick.
D. Equipment, Exposed, up to 48 inches (1200 mm) in Diameter or with Flat Surfaces up to 72 inches (1800 mm):
   1. Aluminum Stucco Embossed: 0.016 inch thick.
E. Equipment, Exposed, Larger than 48 inches (1200 mm) in Diameter or with Flat Surfaces Larger than 72 inches (1800 mm):
   1. Aluminum Stucco Embossed with 1-1/4-Inch (32-mm) Deep Corrugations thick.

END OF SECTION 23 07 16

SECTION 23 07 19 – HVAC PIPING 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.

1.02 SUMMARY:

A. This SECTION includes requirements for insulating HVAC piping systems:

1. Indoor and outdoor condensate piping.
2. Indoor and outdoor cold piping.
3. Indoor and outdoor hot piping.

1.03 RELATED REQUIREMENTS:

1. SECTION 23 07 13 - DUCT INSULATION.
2. SECTION 23 07 16 - HVAC EQUIPMENT INSULATION.
3. SECTION 23 21 13.13 - UNDERGROUND HYDRONIC PIPING.

1.04 REFERENCE STANDARDS:

A. Applicable Standards (Latest Edition):

1. ASTM International (ASTM):
    a. ASTM A167 - Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
    b. ASTM A240/A240M - Specification for Chromium and Chromium-Nickel Stainless-Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
    c. ASTM B209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
    d. ASTM B209M - Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
    e. ASTM C195 - Specification for Mineral Fiber Thermal Insulating Cement.
    f. ASTM C196 - Specification for Expanded or Exfoliated Vermiculite Thermal Insulating Cement.
    g. ASTM C449 - Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
    h. ASTM C450 - Practice for Fabrication of Thermal Insulation Fitting Covers for NPS Piping, and Vessel Lagging.
    i. ASTM C533 - Specification for Calcium Silicate Block and Pipe Thermal Insulation.
    j. ASTM C534 - Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
    k. ASTM C547 - Specification for Mineral Fiber Pipe Insulation.
    l. ASTM C552 - Specification for Cellular Glass Thermal Insulation.
    m. ASTM C553 - Specification for Mineral Fiber Blanket and Thermal Insulation for Commercial and Industrial Applications.
    n. ASTM C585 - Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
    o. ASTM C591 - Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
    p. ASTM C612 - Specification for Mineral Fiber Block and Board Thermal Insulation.

q. ASTM C795 - Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
r. ASTM C871 - Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate, and Sodium Ions.
s. ASTM C921 - Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
t. ASTM C1136 - Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
u. ASTM C1290 - Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
v. ASTM C1393 - Specification for Perpendicularly Oriented Mineral Fiber Roll and Sheet Thermal Insulation for Pipes and Tanks.
w. ASTM D1644 - Test Methods for Nonvolatile Content of Varnishes.
x. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.
y. ASTM E96/E96M - Test Methods for Water Vapor Transmission of Materials.
z. ASTM F1249 - Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor.

2. Code of Federal Regulations (CFR):
   a. 40 CFR - Protection of Environment, Chapter I - Environmental Protection Agency, Part 59 - "National Volatile Organic Compound Emission Standards for Consumer and Commercial Products," Subpart D - "National Volatile Organic Compound Emission Standards for Architectural Coatings", 2007.

1.05 SUBMITTALS:

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).
B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Completed detail plates pertinent to each of the below defined details from the National Commercial and Industrial Insulation Standards manual will meet this requirement for shop drawings.
1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.
C. Qualification Data: For qualified Installer.
D. 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.
E. Field quality-control reports.

1.06 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. Products shall not contain formaldehyde, asbestos, lead, mercury, mercury compounds, or polybrominated diphenyl ether fire retardants.

C. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.07 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.

1.08 COORDINATION:

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT.

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.09 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. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS:

A. Comply with requirements in "Piping Insulation Schedule, General" and " Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain formaldehyde, 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. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534, Type I for tubular materials.

1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. Aeroflex USA, Inc.; Aerocel.
   b. Armacell, LLC; AP Armaflex.
   c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

G. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C612, Type IB. Nominal density is 2.5 lb./cu. ft. (40 kg/cu. m) or more. Thermal conductivity (k-value) at 100ºF (55ºC) is 0.29 Btu by in./h by sq. ft. by ºF (0.042 W/m by K) or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. CertainTeed Corp.; CrimpWrap.
   b. Johns Manville; MicroFlex.
   c. Knauf Insulation; Pipe and Tank Insulation.
   d. Manson Insulation, Inc.; AK Flex.
   e. Owens Corning; Fiberglas Pipe and Tank Insulation.

H. Mineral-Fiber, Pipe Insulation: Mineral or glass fibers bonded with a bio-based thermosetting resin. Preformed, factory pre-slit pipe covering insulation complying with ASTM C 547, Type I (850 degrees F) or Type IV (1000 degrees F); ASTM C 585, ASTM C 411, ASTM C 795, and UL/ULC Classified. Provide with factory-applied white ASJ SSL or white ASJ+ SSL+ vapor retarder jacket complying with ASTM C 1136. Thermal conductivity ASTM C 335 (k-value) at 75 deg. F mean temperature shall be 0.23 Btu x in. /h x sq. ft. x degrees F, or less. Maximum service temperature of 1,000 degrees F. Flame/Smoke Rating (ASTM E84) of 25/50. Must be validated formaldehyde-free.

1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. Knauf Insulation; Earthwool® 1000 Pipe Insulation.
   b. Manson Insulation; Alley-K® Pipe Insulation.
   c. Owens Corning; Fiberglass Pipe Insulation
   d. Johns Manville

2.02 INSULATING CEMENTS:

A. Mineral-Fiber Insulating Cement: Comply with ASTM C195.

1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. Ramco Insulation, Inc.; Super-Stik.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.

1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. Ramco Insulation, Inc.; Thermokote V.

2.03 ADHESIVES:

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. Aeroflex USA, Inc.; Aeroseal.
   b. Armacell, LLC; Armaflex 520 Adhesive.

c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
d. K-Flex USA; R-373 Contact Adhesive.

2. 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).
3. 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."

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
   b. Eagle Bridges - Marathon Industries; 225.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
   d. Mon-Eco Industries, Inc.; 22-25.
2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. 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."

D. ASJ Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
   b. Eagle Bridges - Marathon Industries; 225.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
   d. Mon-Eco Industries, Inc.; 22-25.
2. 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).
3. 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."

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. Dow Corning Corporation; 739, Dow Silicone.
   b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
   c. P.I.C. Plastics, Inc.; Welding Adhesive.
   d. Speedline Corporation; Polyco VP Adhesive.
2. 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).
3. 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."

2.04 MASTICS:

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Products: Subject to compliance with requirements, provide products by one of the following:
    a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
    b. Vimasco Corporation; 749.
2. Water-Vapor Permeance: ASTM E96/E96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
3. Service Temperature Range: -20 to +180ºF (-29 to -82ºC).
4. Solids Content: ASTM D1644, 58% by volume and 70% by weight.
5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Products: Subject to compliance with requirements, provide products by one of the following:
    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
    b. Eagle Bridges - Marathon Industries; 550.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
    d. Mon-Eco Industries, Inc.; 55-50.
    e. Vimasco Corporation; WC-1/WC-5.
2. Water-Vapor Permeance: ASTM F1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
3. Service Temperature Range: -20 to +180ºF (-29 to +82ºC).
4. Solids Content: 60% by volume and 66% by weight.
5. Color: White.

2.05 SEALANTS:

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass and Polyisocyanurate Products: Subject to compliance with requirements, provide products by one of the following:
    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
    b. Eagle Bridges - Marathon Industries; 405.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
    d. Mon-Eco Industries, Inc.; 44-05.
    e. Pittsburgh Corning Corporation; Pittseal 444.
2. Joint Sealants for Polystyrene Products: Subject to compliance with requirements, provide products by one of the following:
    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-70.
    b. Eagle Bridges - Marathon Industries; 405.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.

d. Mon-Eco Industries, Inc.; 44-05.

3. Materials shall be compatible with insulation materials, jackets, and substrates.
4. Permanently flexible, elastomeric sealant.
5. Service Temperature Range: -100 to +300ºF (-73 to +149ºC).
6. Color: White or gray.
7. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
8. Sealants 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. Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
   b. Eagle Bridges - Marathon Industries; 405.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
   d. Mon-Eco Industries, Inc.; 44-05.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: -40 to +250ºF (-40 to +121ºC).
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants 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."

C. ASJ Flashing Sealantsand PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: -40 to +250ºF (-40 to +121ºC).
5. Color: White.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants 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 FACTORY-APPLIED JACKETS:

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, Kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
2. ASJ+: Polymer-film, white kraft paper, fiberglass-scrim reinforced, with aluminum foil backing, complying with ASTM C1136, Type I, II, III, IV, VII, VIII, X.

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. Products: Subject to compliance with requirements, provide products by one of the following:
    a. Johns Manville; Zeston.
    b. P.I.C. Plastics, Inc.; FG Series.
    c. Proto Corporation; LoSmoke.
    d. Speedline Corporation; SmokeSafe.
2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
    a. 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.

C. Metal Jacket:

1. Products: Subject to compliance with requirements, provide products by one of the following:
    a. Childers Brand, Johns Manville; Metal Jacketing Systems.
    b. Ideal Products Metal Jacketing Systems.
    c. RPR Products, Inc.; Insul-Mate.
2. Aluminum Jacket: Comply with ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.
    a. Finish and thickness are indicated in field-applied jacket schedules.
    b. Moisture Barrier for Indoor Applications: 2.5 mil (0.063 mm) thick polysurlyn.
    c. Moisture Barrier for Outdoor Applications: 2.5 mil (0.063 mm) thick polysurlyn.
    d. Factory-Fabricated Fitting Covers:
        (1) Same material, finish, and thickness as jacket.
        (2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
        (3) Tee covers.
        (4) Flange and union covers.
        (5) End caps.
        (6) Beveled collars.
        (7) Valve covers.
        (8) 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.

1. Products: Subject to compliance with requirements, provide products by one of the following:
    a. ABI, Ideal Tape Division; 428 AWF ASJ.
    b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
    c. Compac Corporation; 104 and 105.
    d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
2. Width: 3 inches (75 mm).

3. Thickness: 11.5 mils (0.29 mm).
4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
5. Elongation: 2%.
6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. ABI, Ideal Tape Division; 370 White PVC tape.
   b. Compac Corporation; 130.
   c. Venture Tape; 1506 CW NS.
2. Width: 2 inches (50 mm).
3. Thickness: 6 mils (0.15 mm).
4. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
5. Elongation: 500%.
6. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. ABI, Ideal Tape Division; 488 AWF.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   c. Compac Corporation; 120.
   d. Venture Tape; 3520 CW.
2. Width: 2 inches (50 mm).
3. Thickness: 3.7 mils (0.093 mm).
4. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
5. Elongation: 5%.
6. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

2.09 SECUREMENTS:

A. Bands:

1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. ITW Insulation Systems; Gerrard Strapping and Seals.
   b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
2. Stainless Steel: ASTM A167 or ASTM A240/A240M, Type 304 or Type 316; 0.015 inch (0.38 mm) thick, 1/2 inch (13 mm) wide with wing seal or closed seal.

B. Staples: Outward-clinching insulation staples, nominal 1/2 inch (13 mm) wide, stainless steel or Monel.

C. Wire: 0.080-inch (2.0-mm) nickel-copper alloy 0.062-inch (1.6-mm) soft-annealed, stainless steel or 0.062-inch (1.6-mm) soft-annealed, galvanized steel.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. C & F Wire.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
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.

1.

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 GENERAL INSTALLATION REQUIREMENTS:

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, 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. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete run. Do not use cut pieces or scraps abutting each other

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. .
3. Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 3" wide vapor barrier tape or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3" wide vapor barrier tape or band
4. 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 1-1/2 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.
    a. For below-ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

O. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.04 PENETRATION:

A. Insulation Installation at Roof Penetrations: Install insulation per details on drawings.

1. Seal penetrations with flashing, counter flashing and sealant as required for a weatherproof seal.
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 Underground 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: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in DIVISION 07 for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in DIVISION 07.

3.05 GENERAL PIPE INSULATION INSTALLATION:

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. 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.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as 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.
5. 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.
6. Insulate flanges and 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.
7. 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.
8. 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.
9. Label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gauges, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. 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.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Removable covers are to be installed on:
    a. All Strainers, Manual Flow Balance Valve and Automtic Flow Valves.
    b. All heating hot water and steam accessories located within mechanical rooms.
2. 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.
3. 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.
4. 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.
5. 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.
6. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.06 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION:

A. Seal longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install 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.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams 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. 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.

B. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturers recommended adhesive.
1. 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. Pipe Insulation with ASJ, Paint jacket with paint system identified below and as specified in SECTION 09 91 13 - EXTERIOR PAINTING and SECTION 09 91 23 - INTERIOR PAINTING.
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.
    a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.09 PIPING INSULATION SCHEDULE, GENERAL:

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
1. Drainage piping located in crawl spaces.
2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.
3. Hot piping within radiation enclosures or unit cabinets
4. Cold piping within cabinets provided piping is located over drain pan.
5. Hot piping beyond control valve as long as control valve is located in heated space.
6. Steam condensate piping between steam trap and unions```

3.10 PIPING INSULATION SCHEDULE:

System Type	Insulation Material	Jacket*	Branches, Mains, and Loops				
			Pipe Diameter (inches)				
			<1	1-1¼	1½-3	4-6	8>
			Insulation Thickness (inches)				
Chilled Water & Glycol Drycooler Piping	Flexible Elastomeric	None	1	1	1	1	1
AC Condensate	Flexible Elastomeric	None	1	1	1	1	1
Refrigerant Suction Line, interior	Flexible Elastomeric	None	1	1	1	1	1.5
Refrigerant Suction Line, Exterior	Flexible Elastomeric	Aluminum	1.5	1.5	1.5	1.5	2
Heating Hot Water Supply	Mineral-Fiber	ASJ	1.5	1.5	2	2	2
Heating Hot Water Return	Mineral-Fiber	ASJ	1.5	1.5	2	2	2

* Jacket Requirements
1) All exterior exposed piping shall have smooth surfaced, weather resistant, waterproof aluminum jacket.
2) All new interior piping exposed to view in occupied areas shall be painted to match surrounding background
3) All new interior piping exposed to view in occupied areas and within 6 feet of the finished floor shall have PVC jacket installed
4) All new interior piping that is exposed in mechanical rooms and within 8 feet of the floor shall have aluminum jacket installed.

END OF SECTION 23 07 19

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SECTION 23 08 00 – MECHANICAL COMMISSIONING REQUIREMENTS

PART 1 GENERAL

1.01 WORK INCLUDES:
- A. Validation of proper installation of DIVISION 23 systems and equipment
- B. Systems and equipment testing and startup
- C. Equipment performance verification
- D. Functional testing of control systems
- E. Documentation of tests, procedures and installations
- F. Coordination of training

1.02 SCOPE INCLUDES:
- A. Systems to be commissioned include the following:
  1. Chilled Water Systems
  2. Heating Hot Water Systems
  3. Air Handling Systems
  4. Terminal Heating Units
  5. Valve Tags
  6. Insulation and labeling of pipe/duct/equipment
  7. Specialty Fans
  8. Variable Frequency Drives
  9. Building Automation System
  10. Building Pressures
  11. Life Safety Systems
      - a. HVAC Equipment Shutdown via Fire Alarm
      - b. Smoke Control Systems
      - c. All negative and positive pressure rooms that have differential pressure monitors.

1.03 RELATED DOCUMENTS:
- A. Commissioning Plan - This plan is part of the Contract Documents and outlines many responsibilities, procedures and tasks throughout the commissioning process.
- B. SECTION 01 91 13 – GENERAL COMMISSIONING REQUIREMENTS
- C. SECTION 22 08 00 – PLUMBING COMMISSIONING REQUIREMENTS
- D. SECTION 26 08 00 – ELECTRICAL COMMISSIONING REQUIREMENTS
- E. DIVISION 23 SECTIONS - Individual Sections stipulate installation, startup, warranty and training requirements for the system or device specified in that Section.

1.04 REFERENCES:
- A. ASHRAE Guideline 0-2013: The HVAC Commissioning Process.
- B. ANSI/NEBB S110-2018 - Whole Building Technical Commissioning of New Construction

1.05 GENERAL DESCRIPTION:
- A. Commissioning is a process to assure all building systems are installed and perform interactively according to the design intent; the systems are efficient, cost effective and meet the Owner's operational needs; the installation is adequately documented; and operating personnel are adequately trained. Commissioning serves as a tool to minimize post-occupancy operational problems. It establishes testing and communication protocols in an effort to advance building systems from installation to fully optimized operation.

B. The Commissioning Authority will work with the Contractor and Design Engineer to coordinate, oversee, and document the commissioning process during the Construction Phase of this project.

C. This SECTION defines responsibilities of the Contractor to facilitate the commissioning process particularly during the Construction Phase of the project.

1.06 DEFINITIONS:

A. Refer to specification SECTION 01 91 13 for definitions related to the commissioning process.

1.07 DOCUMENTATION:

A. Contractor shall send Commissioning Authority one copy of the following per the procedures specified in other sections of the Specification:

1. Shop drawings and product data related to systems and equipment to be commissioned on this project. CxA will review and incorporate comments via the Design Engineer.
2. Initial draft of equipment startup plan checklists along with manufacturers' startup procedures. CxA will assist in development and recommend approval.
3. System Test Reports. CxA will review and compile prior to FPT.
4. System certificate of readiness including completed equipment startup forms along with the manufacturers' field or factory performance test documentation. CxA will review and approve prior to FPT.
5. Completed Test and Balance Reports. CxA will review and approve prior to FPT.
6. Equipment Warranties.
7. Training Plans.
8. O&M documentation per requirements of the Commissioning Plan and the Specifications, DIVISION 01.
9. Record Drawings: Contractor shall maintain at the site an updated set of record or "as-built" documents reflecting actual installed conditions. As-built drawings will be updated in electronic format by the Contractor and submitted to the CxA on a regular basis.

1.08 SEQUENCING AND SCHEDULING:

A. Systems can be in various stages of the commissioning process where appropriate, in order to expedite close out of the facility. The CxA and Contractor shall cooperate to schedule Cx tasks to minimize the duration of Cx activities. Sequential priorities shall be followed per the Cx Plan.

B. Commissioning Schedule - Contractor shall incorporate the commissioning process into the project schedule. Startup, TAB and FPT shall be itemized as applicable for each system. Durations for each task shall be coordinated with the CxA.

1.09 COORDINATION MANAGEMENT PROTOCOLS:

A. Coordination responsibilities and management protocols relative to Cx are initially defined in the Cx Plan but will be refined and documented at the commissioning scoping meeting. Contractor shall have input to the protocols and all parties will commit to scheduling obligations. The CxA will record and distribute notes from the meeting.

1.10 CONTRACTOR RESPONSIBILITIES:

A. Construction Phase
   1. Include commissioning requirements in price and plan for work.
   2. Attend scoping and coordination meetings scheduled by the CxA.
   3. Remedy deficiencies identified during the construction period.
   4. Prepare and submit required draft forms and equipment information requested by the CxA. Typically this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, fan and pump curves, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation, start-up and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the CxA.
   5. Assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
   6. Provide limited assistance to the CxA in preparing the specific functional performance test procedures. Contractors shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
   7. Thoroughly complete and inspect installation of systems and equipment in accordance with the Contract Documents, reference or industry standards, and specifically Part 3 of this SECTION.
   8. Startup systems and equipment prior to verification and performance testing by the CxA. Startup procedures shall be in accordance with Contract Documents, reference or industry standards, and specifically Part 3 of this SECTION.
   9. Record startup and test procedures on startup forms and checklists and certify the systems and equipment have been started and tested in accordance with the Contract Documents, reference or industry standards, and specifically Part 3 of this SECTION. Each form shall be signed and dated by the individual responsible for the startup or test.
   10. Complete pre-approved startup checklists and submit along with other installation certification documentation such as pre-functional checks, certificate of readiness, warranties, test results, etc.
   11. Schedule and coordinate Cx efforts required by appropriate subcontractors and vendors. Participate in respective portions of start-ups and training.
   12. Demonstrate the systems as specified.
   13. Certify systems have been installed and are operating per Contract Documents through certificates of readiness.
   14. Maintain an updated set of record documentation.
   15. Copy CxA on indicated documentation.
   16. Conduct equipment operation, maintenance, diagnosis and repair training as required by the respective section of the Specifications.

B. Acceptance Phase
   1. Assist CxA in verification and performance testing. Assistance will generally include the following:
      a. Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present

during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.

b. Manipulate systems and equipment to facilitate testing.

c. Manipulate control systems to facilitate verification and performance testing.

d. Provide a Controls technician to work at the direction of CxA for up to 40 hours beyond assistance specified above.

2. Correct any work not in accordance with Contract Documents and non-conformances included in the commissioning issues log.

3. Participate in the systems and operational training as it relates to O&M information and the Preventative Maintenance (PM) program.

C. Warranty Phase

1. Provide warranty service.

2. Participate in the opposite season and deferred functional testing.

3. Correct any deficiencies identified.

4. Update record documentation to reflect any changes made throughout the Warranty Phase.

1.11 CONTROLS CONTRACTOR RESPONSIBILITIES:

A. Controls contractor shall assist owner during commissioning and start-up of control system and provide detailed drawings of hardwired safety circuits.

1.12 CONTRACTOR NOTIFICATION:

A. Contractor shall completely install, thoroughly inspect, startup, test adjust and balance systems and equipment. All activities shall be documented on specified forms. Contractor shall notify Design Engineer, Owner and CxA via the certification of readiness that systems are complete and ready for verification and functional performance testing.

B. Contractor shall notify CxA at least 10 business days in advance of any tests, startups or training. CxA shall witness selected tests and startups.

1.13 STARTUP CHECKLISTS:

A. Startup checklists for each type of equipment and system shall be submitted to CxA for approval prior to startup. The forms shall be designed by the appropriate subcontractors or vendors to meet the requirements of the Contract Documents. Forms shall be developed for the specific equipment being installed for this project.

B. Startup checklists shall generally include the following for each (as applicable):

1. Project specific designation, location and service

2. Pertinent nameplate data

3. Indication of the party performing the test

4. Field for signature of the startup technician along with the date

5. Clear explanation of the inspection, test, measurement, etc. with a pass/fail indication and a record of measurement parameters

6. Checklist space indicating all O&M instructions, warranties, and record documents have been completed and submitted.

7. Checklist space that proper maintenance clearances have been maintained

8. Checklist space indicating that any required special tools and/or spare tools were turned over to the Owner

9. Checklist space indicating that required prerequisite equipment and systems were successfully started.

C. Startup checklists shall incorporate the manufacturer-specified procedures. Contractor shall compile the startup and checkout procedures indicated in the manufacturer's documentation prior to designing the forms. Include specified acceptance criteria as applicable. The manufacturer's startup and checkout procedures shall be submitted to the CxA along with the draft startup checklists.

D. Completed startup plans for all pieces of equipment included in a system shall be submitted to CxA prior to verification and performance testing.

E. See specification 01 91 13 for additional information regarding Startup and Prefunctional Checklists.

1.14 FUNCTIONAL PERFORMANCE TESTING:

A. Participation: CxA will coordinate, test and/or witness functional performance tests after the successful startup and documentation of systems and equipment is complete. Contractor shall occasionally assist, as described above, with manipulation of the systems or equipment; provision of supporting equipment or materials (lifts, ladders, specialty test equipment, etc.); and on the spot remediation of minor identified deficiencies.

B. Detailed Test Forms: CxA will prepare detailed testing procedures and forms in accordance with the contract documents to conduct and document the FPT. These will be developed during the Construction Phase and completed during the Acceptance Phase.

C. Completeness: All systems must be complete and ready for FPT. TAB work must be complete and the control systems must be tested and started for the respective system or component.

D. Test Documentation: CxA will record test results on the forms developed for the testing. CxA will Pass or Fail the testing and record the date and time of the test. Deficiencies shall clearly indicate when the test has failed. CxA shall recommend acceptance of the system or component after all related testing is successfully complete.

E. Deficiencies and Retesting: When deficiencies are identified during testing, depending on their extent or magnitude, they can be corrected during the test and the testing can continue to successful completion. Significant deficiencies will fail the test and require retesting of the affected portions of the test. The CxA will subsequently track the resolution of the deficiency via the Project Deficiency List. All tests shall be repeated until successful completion.

F. Opposite Season Testing: Testing procedures shall be repeated and/or conducted as necessary during appropriate seasons. "Opposite season" testing will be required where scheduling prohibits thorough testing in all modes of operation.

1.15 TRAINING:

A. Contractors shall prepare and conduct training sessions on the installed systems and equipment for which they are responsible.

B. Contractor shall compile the training plans of the subcontractors and vendors and present a comprehensive training plan as outlined in SECTION 01 79 00.

C. Equipment Specific Training: The appropriate Contractor shall instruct the Owner's designated representative on the safe and proper operation, maintenance, diagnosis and repair of each piece of equipment. Submitted O&M information shall be used during training. Sessions shall include as a minimum:

1. Conceptual overview of how the equipment works
2. Contact information including names, addresses, phone numbers, etc. of sources for equipment information, tools, spare parts, etc.

3. Details of the warranty or guarantee
4. Intended sequences of operation in all modes of operation
5. Limits of responsibility (ex: unit mounted control vs. building management system)
6. Sources of utility support
7. Routine operator tasks involving monitoring and operation covering all modes of operation and mode switching as applicable
8. Relevant health and safety practices/concerns
9. Common problems and their diagnosis and repair
10. Proper maintenance schedules, tasks and procedures with demonstrations
11. Emergency response, documentation and recovery procedures

D. Controls Contractor Training Involvement: Training on the proper use and operation of the control system is specified in the control section of the specification. Controls contractor shall also participate in the overall systems training.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.01 GENERAL:

A. This SECTION outlines general startup, checkout, and functional testing requirements for systems and equipment. Generally these procedures are the direct responsibility of the Contractor as a basic element of validating that the installation is correct. These requirements along with those specified in the individual Section provide a minimum guideline for development of startup procedures, checklists and tests. Contractor shall synthesize these requirements with that of the manufacturer's and/or applicable codes and standards to develop specific and itemized startup procedures specific to that installed on this project.

B. Refer to all DIVISION 23 Specifications for tests performed on installed equipment and systems.

3.02 STARTUP:

A. The HVAC mechanical and controls contractors shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this SECTION and in 01 91 13. The Contractor has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the commissioning authority or Owner.

B. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the CxA, Contractor, and Owner. Beginning system testing before full completion does not relieve the Contractor from fully completing the system, including all startup plan checklists as soon as possible.

3.03 VALVES – STARTUP/CHECKOUT:

A. Operate all valves, manual and automatic, through their full stroke. Ensure smooth operation through full stroke and appropriate sealing or shutoff.

B. Verify actuators are properly installed with adequate clearance.

3.04 METERS AND GAUGES – STARTUP/CHECKOUT:

A. Adjust faces of meters and gages to proper angle for best visibility.
B. Clean windows of meters and gauges and factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touch-up paint. For meters and gauges requiring temporary manual connection of read-out device, such as pressure taps on a flow measuring device, ensure threads are clean and that connection can be made easily.
C. Meters and gauges requiring manual connection of readout device shall be installed with adequate access to allow connection of device with normal tools.

3.05 MECHANICAL IDENTIFICATION – STARTUP/CHECKOUT:

A. Verify all valve tags, piping, duct and equipment labeling corresponds with drawings and indices and meets required Specifications. Correct any deficiencies for all piping and duct systems.
B. Adjusting: Relocate any mechanical identification device that becomes visually blocked by work from this DIVISION or other Divisions.
C. Cleaning: Clean face of identification devices and frames of valve charts.

3.06 MECHANICAL INSULATION – STARTUP/CHECKOUT:

A. Examine all systems and equipment that are specified to be insulated. Patch and repair all insulation damaged after installation. Ensure the integrity of vapor barrier around all cold surfaces.

3.07 PIPING – STARTUP/CHECKOUT:

A. This applies to all piping systems installed including underground site utilities.
B. Inspect all piping for proper installation; adequate support with appropriate vibration isolation where applicable; and adequate isolation valves for required service.
C. Flush all piping and clean all strainers.
D. Ensure adequate drainage is provided at low points and venting is provided at high points. Ensure air is thoroughly removed from the system as applicable.
E. Ensure all piping is adequately supported and anchored to allow expansion. Bump across the line pumps and inspect for excessive pipe movement.
F. Pressure and/or leak test all applicable systems in accordance with requirements in Specifications, ASME B31.1, and B31.9 as applicable.
G. Sterilize applicable piping systems as specified in the Specifications and as required by regulatory authorities.
H. Submit test reports that document the testing results with certification of the results.
I. Verify the operation of safety relief valves, operating controls, safety controls, etc. to ensure a safe installation.
J. Set and adjust fill pressure and level controls to the required setting.

3.08 AC MOTORS – STARTUP/CHECKOUT:

A. Verify proper alignment, installation and rotation.
B. Measure insulation resistance, phase balance, and resistance to ground.
C. Verify properly sized overloads are in place.
D. Measure voltage available to all phases. Measure amps and RPM after motor has been placed in operation under load.
E. Record all motor nameplate data.

3.09 VARIABLE SPEED DRIVES – STARTUP/CHECKOUT:

A. General: Provide the services of a factory-authorized representative to test and inspect equipment installation, provide startup service and to demonstrate and train Owner's personnel.

B. Startup Checks: Perform the following checks before startup and as specified in manufacturer's startup instructions:
   1. Check for shipping damage.
   2. Perform a point-to-point continuity test for all field installed wiring interconnections. Verify terminations of field installed wiring.
   3. Check for proper torque on connections.
   4. Verify use of shielded cable where specified and check that shields have been terminated properly.
   5. Verify grounding.
   6. Check motor nameplate against drive input rating.
   7. Manually rotate motor shaft to ensure free rotation.
   8. Check that motor leads are not grounded.

C. Starting Procedures: Follow the manufacturer's written procedures with the following as a minimum:
   1. Ensure device and system which drive is serving is configured to withstand the device operation specified below.
   2. Adjust the minimum voltage to enable starting but not to draw excessive power at start.
   3. Adjust the Volts/Hz to proper setting.
   4. Adjust the acceleration and deceleration rates to the specified times.
   5. Adjust current limiting to coordinate with the overcurrent device and protect the motor.
   6. Set the maximum and minimum speed.
   7. Manually ramp fan speed from minimum to maximum and check for excessive noise and vibration.
   8. Determine any critical speeds to avoid and set these in the drive.
   9. Verify proper motor rotation in both, Normal and Bypass (if applicable) modes.
   10. Record the motor terminal voltage.
   11. Verify and document proper setup of redundant drives.
   12. Verify and document proper operation of bypasses.

D. Training: Train Owner's maintenance personnel on the following:
   1. Procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventative maintenance and how to obtain replacement parts.
   2. Review data in O&M manuals.

3.10 HYDRONIC PIPING – STARTUP/CHECKOUT:

A. Prepare hydronic piping and test in accordance with requirements in the Specifications, ASME B31.1 and B31.9 as applicable.

B. Flush system with clean water and clean strainers.

C. Chemical Treatment: Provide a water analysis prepared by the chemical treatment supplier to determine the type and level of chemicals required for prevention of scale and corrosion. Perform initial treatment after completion of system testing.

D. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.

E. Set automatic fill valves for required system pressure.
F. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).
G. Set and coordinate automatic fill pressure and relief valve settings.

3.11 PUMPS – STARTUP/CHECKOUT:
A. Check suction line connections for tightness to avoid drawing air into the pump.
B. Clean and lubricate all bearings.
C. Refer to AC Motors in this SECTION.
D. Check that pump is free to rotate by hand. Pump shall be free to rotate with the pump hot and cold for pumps handling hot liquids. If the pump is bound or even drags slightly do not operate the pump until the cause of the trouble is determined and corrected.
E. Check motor for proper rotation. Rotation shall match direction of rotation marked on pump casing. Rotation shall be checked with VFD operating in normal and bypass modes (if applicable).
F. Clean associated strainers.
G. Once system flush is complete, remove startup strainers and affix to adjacent piping to allow confirmation of removal.
H. Check that the proper overloads have been installed in the starter and are the correct size.
I. Verify that the integrity of the vibration isolation is maintained throughout the support and the connections.
J. Align pump within manufacturer's recommended tolerances.
K. Ensure all associated piping has been cleaned, tested, and vented.
L. Start the pump per the manufacturer's instructions.
M. Check the general mechanical operation of the pump and motor.
N. Verify that all thermometers and gauges are installed, are clean and undamaged, and are functional.
O. Verify the check valve seal is appropriate.
P. Check noise and vibration levels and ensure they are within the manufacturer's recommended tolerances.
Q. Refer to SECTION 23 05 93 TESTING, ADJUSTING AND BALANCING for detailed requirements for testing, adjusting and balancing hydronic systems.
R. Check the Net Positive Suction Head (NPSH) is within allowable limits for the operating condition.

3.12 HEAT EXCHANGERS / DRYCOOLERS – STARTUP/CHECKOUT:
A. Inspect the field assembly of components and installation of heat exchangers including piping, controls, and electrical connections.
B. Verify unit is secure on mountings, supporting devices, and connections for piping, controls, and electrical are complete.
C. Verify adequate access for maintenance.
D. Check power and control voltages.

3.13 TERMINAL UNITS – STARTUP/CHECKOUT:
A. General: After construction and painting is complete, clean unit exposed surfaces and vacuum terminal coils and inside of cabinets.
B. Repair scratched and marred surfaces of factory-finished cabinets using finish materials furnished by manufacturer.

C. Verify adequate access for maintenance.
D. Install new filters where required.
E. Check power and control voltages.
F. Check rotation of fan where applicable.
G. Check calibration and operation of the controlling elements.
H. Check control valves for required close off and fail position.

3.14 VAV TERMINAL UNITS – STARTUP/CHECKOUT:

A. Ensure unit is properly supported and that integrity of vibration isolation has been maintained where applicable.
B. Ensure the air velocity sensor is correctly installed and that inlet/outlet restrictions for accurate measurements have been met.
C. Ensure air inlet is free of obstructions. Start fans and ensure proper rotation (as applicable).
D. Measure and record motor amperage and voltage (as applicable).
E. Install new filters where required.
F. Calibrate and adjust the airflow control parameters. Set applicable minimum and maximum setpoints. Coordinate with the Building Management System (BMS) contractor as necessary to obtain flow parameters.
G. Check the heating device and control to ensure functionality and proper installation. Check stroke and range on the valve and ensure it closes and seals tightly. Ensure the coils are undamaged, combed, and vented.
H. Refer to SECTION 23 05 93 TESTING, ADJUSTING, AND BALANCING and coordinate work.

3.15 AIR HANDLING UNITS – STARTUP/CHECKOUT:

A. Inspect the field assembly of components and installation of air handling units (AHU) including piping, ductwork and electrical connections.
B. Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Vacuum fan wheel, fan cabinet, and coils entering air face. Ensure volatile irritants are contained and kept out of occupied spaces.
C. Adjust and lubricate dampers and linkages for proper damper operation.
D. Ensure field fabricated unit sections are properly connected within acceptable tolerances.
E. Seal all penetrations air tight and ensure access doors seat tightly.
F. Verify unit is secure on mountings and supporting devices and connections for piping, ductwork and electrical are complete.
G. Verify proper thermal overload protection is installed in motors, starters and disconnects.
H. Ensure vibration isolation integrity and the connections to it are maintained throughout the AHU installation.
I. Refer to AC Motors in this SECTION.
J. Disconnect fan drive from motor and verify proper motor rotation direction; verify fan wheel free rotation; and verify smooth bearing operations. Reconnect fan drive system, align belts and install belt guards. Rotation shall be checked with VFD operating in normal and bypass modes (if applicable).
K. Lubricate bearings, pulleys, belts and other moving parts with factory-recommended lubricants.
L. Comb coil fins for parallel orientation.
M. Install clean filters.
N. Ensure condensate drains properly and trap is adequate.

O. Stroke all valves and dampers to ensure free and full travel.
P. Pressure test units as required in the AHU Specification.
Q. Refer to SECTION 23 05 93 TESTING, ADJUSTING, AND BALANCING for detailed requirements for testing, adjusting, and balancing air handling systems.
R. Refer to SECTION 23 09 00 HVAC INSTRUMENTATION AND CONTROLS for detailed requirements for starting the controls related to the air handling systems.
S. Training: Train Owner's maintenance personnel on the following:
   1. Procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventative maintenance and how to obtain replacement parts.
   2. Review data in O&M manuals.

3.16 FANS – STARTUP/CHECKOUT:
A. Inspect the field assembly of components and installation of fans including ductwork and electrical connections.
B. Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Vacuum fan wheel, fan cabinet and coils entering air face. Ensure volatile irritants are contained and kept out of occupied spaces.
C. Adjust and lubricate dampers and linkages for proper damper operation.
D. Verify unit is secure on mountings and supporting devices and connections for ductwork and electrical are complete.
E. Verify proper thermal overload protection is installed in motors, starters and disconnects.
F. Ensure vibration isolation integrity and the connections to it are maintained with the fan installation.
G. Refer to AC Motors in this SECTION.
H. Disconnect fan drive from motor and verify proper motor rotation direction; verify fan wheel free rotation; and verify smooth bearing operations. Reconnect fan drive system, align belts and install belt guards. Rotation shall be checked with VFD operating in normal and bypass modes (if applicable).
I. Lubricate bearings, pulleys, belts and other moving parts with factory-recommended lubricants.
J. Stroke all dampers to ensure free and full travel.
K. Refer to SECTION 23 05 93 TESTING, ADJUSTING, AND BALANCING for detailed requirements for testing, adjusting, and balancing fans.
L. Refer to SECTION 23 09 00 HVAC INSTRUMENTATION AND CONTROLS for detailed requirements for starting the controls related to the fans.
M. Training: Train Owner's maintenance personnel on the following:
   1. Procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventative maintenance and how to obtain replacement parts.
   2. Review data in O&M manuals.

3.17 METAL DUCTWORK – STARTUP/CHECKOUT:
A. Leakage Tests: Refer to SECTION 23 31 13 DUCTWORK for duct testing requirements.
B. Clean ductwork internally of dust and debris unit by unit as it is installed. Clean external surfaces of foreign substances, which might cause corrosive deterioration of metal or where ductwork is to be painted might interfere with painting or cause paint deterioration.
C. Strip protective paper from stainless ductwork surfaces and repair finish wherever it has been damaged.

D. Temporary Closure: Provide temporary closure at ends of ducts, which are not connected to equipment or air distribution devices at time of ductwork installation. Use polyethylene film or other covering that will prevent entrance of dust and debris until connections are completed.

E. Balancing: Refer to SECTION 23 05 93 TESTING, ADJUSTING, AND BALANCING for air distribution balancing of metal ductwork. Seal any leaks in ductwork that become apparent in balancing process.

3.18 DUCTWORK ACCESSORIES – STARTUP/CHECKOUT:

A. Operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories as required to obtain proper operation and leak proof performance.
   1. Adjusting: Adjust ductwork accessories for proper settings. Install fusible links in fire dampers and adjust for proper action.
   2. Label access doors in accordance with SECTION 23 05 53 HVAC IDENTIFICATION.
   3. Mark final positioning of manual dampers as specified in SECTION 23 05 93 TESTING, ADJUSTING, AND BALANCING.

B. Fire Damper Testing: For every fire damper, remove the fusible link and verify the damper operates freely and closes tightly. Reinstall the fusible link.

C. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.19 CONTROL SYSTEMS – STARTUP/CHECKOUT:

A. Startup: Controls contractor will assist owner in startup of control systems. This includes verification of sequences, normal and emergency operations, calibration, interfaces, interlocks, etc.

B. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.20 FUNCTIONAL TESTING:

A. This SECTION specifies the functional testing requirements for DIVISION 23 systems and equipment. From these requirements, the Commissioning Authority (CxA) shall develop step-by-step procedures to be executed by the Contractors. The general functional testing process, requirements and test method definitions are described in SECTION 01 91 13. The test requirements for each piece of equipment or system contain the following:
   1. The contractors responsible to execute the tests, under the direction of the CxA
   2. A list of the integral components being tested
   3. Startup plan checklists associated with the components
   4. Functions and modes to be tested
   5. Required conditions of the test for each mode
   6. Special procedures
   7. Required methods of testing
   8. Required monitoring
   9. Acceptance criteria
   10. Sampling strategies allowed

B. Prerequisites:

The following applicable generic prerequisite checklist items are required to be completed and submitted with the equipment/system certificate of readiness and checked off by CxA prior to functional testing.

1. All related equipment has been started up and startup plan checklists submitted and approved ready for functional testing.
2. All control system functions for this and all interlocking systems are programmed and operable per contract documents, including final setpoints and schedules with debugging, loop tuning and sensor calibrations completed.
3. Piping system flushing complete and required report approved
4. Water treatment system complete and operational
5. Test and balance (TAB) complete and approved for the air and hydronic systems
6. All A/E punchlist items for this equipment corrected
7. Schedules and setpoints provided to the CxA
8. False loading equipment, system and procedures ready.
9. Crankcase heaters have been on long enough for immediate startup.
10. Sufficient clearance around equipment for servicing

C. Monitoring:

1. Monitoring is a method of testing as a stand-alone method or to augment manual testing.
2. All points listed in the required monitoring section of the test requirements which are control system monitored points shall be trended by the controls contractor. Other points shall be monitored by the CxA using dataloggers. At the option of the CxA, some control system monitoring may be replaced with datalogger monitoring. At the CxA's request, the controls contractor shall trend up to 20% more points than listed herein at no extra charge.
3. Trend output data must be in a spreadsheet file (Excel or similar) with time continuous down left column and point values in column(s) to the right.
4. All trends for points of a group must start at the same moment in time, unless specifically approved otherwise with the commissioning agent.

3.21
3.21

3.21 CHILLED WATER SYSTEM FPT:

A. Parties Responsible to Execute Functional Test
   1. Controls contractor: operate the controls as needed.
   2. HVAC mechanical contractor or vendor: assist in testing sequences as needed.
   3. Electrical contractor: perform loss of power testing
   4. CxA: to witness, direct and document testing.

B. Integral Components or Related Equipment Being Tested
   1. Chilled water piping system
   2. CHW supply pumps
   3. VFD on pumps

C. Prerequisites: The applicable prerequisite checklist items listed in paragraph 3.22.B shall be listed on each certificate of readiness form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the startup

plan checklists previously completed by the installer, before the beginning of functional testing.

D. Functions / Modes Required To Be Tested, Test Methods and Seasonal Test Requirements: The following testing requirements are an addition to and do not replace any testing requirements elsewhere in this DIVISION.

Function / Mode	Test Method Manual, Monitoring, Either or Both	Required Seasonal Test[1]
General 1. Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, shutdown, unoccupied & manual modes and power failure. Test functionality of this piece of equipment or system in all control strategies or interlocks with which it is associated. A full cycle from no load to full load and then to no load and compressors off shall be demonstrated.	Manual	
In addition to, or as part of (1) above, the following modes or tests are required:		
2. Primary Side. Pump optimization, capacity modulation and primary CHW supply pumps, all relating to maintaining CDW and CHW temperatures. VFD operation: modulation to minimum, control system PID, proportional band of speed vs controlling parameter, alarms, verification of program settings, etc.	Both	Cooling
3. Sensor and actuator calibration checks on: ECDWT, CHWST, pressure sensor controlling pump speed, 3-way valve, and other random checks (BAS readout against handheld calibrated instrument must be within 0.5°F for temps. or within a tolerance equal to 10% of the pressure setpoint, with a test gage)	Manual	
4. Verify schedules and setpoints to be reasonable and appropriate		

[1]Design cooling season, heating season or both. "Design" means within 5°F of season design or 95% of loading design. A blank cell denotes no special seasonal test is required and that test can be executed during any season, if condition simulation is appropriate.

E. Required Monitoring

1. All points listed below which are control system monitored points shall be trended by the controls contractor. Other points shall be monitored by the CxA using dataloggers. Refer to the Monitoring section at paragraph 3.22.C for additional monitoring details

Point	Time Step (min.)	Minimum Time Period of Trend
For each pump:		
CHWST	10	7 days
CHWRT	10	7 days

OSAT-DB	10	7 days
CHWS primary pump current or status	10	7 days
CHWS secondary pump speed, if variable	10	7 days
CHWS secondary pump flow rate	10	7 days
CHWS secondary pump speed controlling parameter value	10	7 days

F. Acceptance Criteria
1. For the conditions, sequences and modes tested, the chillers, integral components and related equipment respond to varying loads and changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.
2. Chiller shall maintain the chilled water supply setpoint to within +/- 1.0°F of the setpoint deadband without excessive hunting.
3. Pumping system and controls shall maintain the current desired pressure setpoint to within an amount equal to 10% of the setpoint value on either side of the deadband without excessive hunting.

END OF REQUIREMENTS FOR CHILLED WATER SYSTEM TEST

3.22 EXHAUST FANS FPT:

A. Parties Responsible to Execute Functional Test
1. Controls contractor: operate the controls to activate the equipment, if BAS controlled.
2. HVAC mechanical contractor or vendor: assist in testing sequences.
3. CxA: to witness, direct and document testing.

B. Integral Components or Related Equipment Being Tested
1. Exhaust fans

C. Prerequisites: The applicable prerequisite checklist items listed in paragraph 3.22.B shall be listed on each certificate of readiness form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the startup plan checklists previously completed by the installer, before the beginning of functional testing.

D. Functions / Modes Required To Be Tested, Test Methods and Seasonal Test Requirements: The following testing requirements are an addition to and do not replace any testing requirements elsewhere in this DIVISION.

Function / Mode	Test Method Manual, Monitoring, Either or Both[1]	Required Seasonal Test
General 1. Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, shutdown, unoccupied & manual modes and power failure. Test functionality of this piece of equipment or system in all control strategies or interlocks that it is associated with.	Manual	

In addition to, or as part of (1) above, the following modes or tests are required:			
2.	Verify schedules and setpoints to be reasonable, appropriate, and coordinated with the Owner's Project Requirements		
3.	Function at fire alarm (off, depressurization, etc.)	Manual	
4.	Interlocks to building pressurization control	Manual	
5.	Speed controls	Either	
6.	Sensor calibration checks on any controlling temperature or pressure sensor	Manual	

[1]Refer to Special Procedures

E. Special Procedures or Conditions
   1. None

F. Required Monitoring
   1. All points listed below which are control system monitored points shall be trended by the controls contractor. Other points shall be monitored by the CxA using dataloggers. Refer to the Monitoring section at paragraph 3.22.C for additional monitoring details

Point	Time Step (min.)	Minimum Time Period of Trend
For each fan:		
EF speed, if variable, else status	10	7 days
Space/building pressure	10	7 days
Space temperature (if applicable)	10	7 days

G. Acceptance Criteria
   1. For the conditions, sequences and modes tested, the fans, integral components and related equipment respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

   END OF REQUIREMENTS FOR EXHAUST FAN TEST

3.23 INDOOR AIR CLIMATE CONTROL--MISC. SYSTEMS FPT:

A. All temperature controlled zones shall be verified to be maintaining proper climate control. Specific test requirements for this may have been identified elsewhere in this specification (e.g., under terminal units). For all areas not specifically specified, otherwise, the following tests shall be conducted.

B. Parties Responsible to Execute Functional Test
   1. Controls contractor: operate the controls and provide trend logs
   2. HVAC mechanical contractor or vendor: assist in testing sequences.
   3. CxA: to witness, direct and document testing.

C. Integral Components or Related Equipment Being Tested
   1. Cooling plant (entire system)
   2. Heating plant (entire system)
   3. Air, water, or steam distribution system
   4. Control system

D. Prerequisites: All listed systems in Part B, above, shall have had successful functional tests completed prior to this test.

E. Functions / Modes Required To Be Tested, Test Methods and Seasonal Test Requirements

1. This is a performance test to verify that the HVAC systems can provide and maintain the temperature and relative humidity levels specified, during normal and extreme weather and occupancy conditions. The test consists of monitoring, via trend logs, of various points when temperatures reach to within 5°F of season design or 95% of loading design.

F. Special Procedures or Conditions

1. Building should be normally occupied during the test.

G. Required Monitoring

1. All points listed below which are control system monitored points shall be trended by the controls contractor. Other points shall be monitored by the CxA using dataloggers. Refer to the Monitoring section at paragraph 3.22.C for additional monitoring details

Point	Time Step (min.)	Minimum Time Period of Trend
Space temperature control:		
Space temperature (summer design)	10	7 days
Space relative humidity (summer design)	10	7 days
Space temperature (winter design)	10	7 days
Space relative humidity (winter design)	10	7 days
OSAT-DB	10	7 days

H. Acceptance Criteria

1. Space temperature during occupied modes shall average within +/- 1°F of setpoint and always remain within 1°F of the ends of the deadband without excessive hunting of either the applicable damper or coil valve, or complaints of drafts or stuffiness from occupants.
2. System and controls shall maintain the space temperature and humidity within the parameters defined in the Contract Documents.

END OF REQUIREMENTS FOR INDOOR AIR CLIMATE CONTROL TEST

3.24 TERMINAL UNITS FPT:

A. Parties Responsible to Execute Functional Test

1. Controls contractor: operate the controls to activate the equipment.
2. HVAC mechanical contractor or vendor: assist in testing sequences.
3. CxA: to witness, direct and document testing.

B. Integral Components or Related Equipment Being Tested

1. Terminal unit (TU)

C. Prerequisites: The applicable prerequisite checklist items listed in paragraph 3.22.B shall be listed on each certificate of readiness form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the startup plan checklists previously completed by the installer, before the beginning of functional testing.

D. Functions / Modes Required To Be Tested, Test Methods and Seasonal Test Requirements: The following testing requirements are an addition to and do not replace any testing requirements elsewhere in this DIVISION.

Function / Mode	Test Method Manual, Monitoring, Either or Both[3]	Required Seasonal Test[1]
General 1. Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, warmup, shutdown, unoccupied & manual modes and power failure and restoration. Test functionality of this piece of equipment or system in all control strategies or interlocks that it is associated with, including all damper, valve and fan functions.	Manual	
In addition to, or as part of (1) above, the following modes or tests are required:		
2. Sensor activator calibration checks on: TU DAT, zone air temperature, damper position and other random checks (BAS readout against visual or hand-held calibrated instrument must be within 0.5°F for temps. or within a tolerance equal to 10% of static pressure setpoint)	Manual	
3. Verify control parameters and setpoints to be reasonable and appropriate by reviewing the full program of all the TU's with each other for consistency. Verify the max. and min. cfm setpoints of all TU's against the control drawing and TAB values.	Observation	
4. Verify no hunting or significant overshoot by damper or valves.	Either	
5. All alarms (fan status, low limits, high static, etc.)	Manual	
6. Verify that TU is maintaining space setpoint temperatures	Monitoring	Both Design

[1]Design cooling season, heating season or both. "Design" means within 5°F of season design or 95% of loading design. A blank cell denotes no special seasonal test is required and that test can be executed during any season, if condition simulation is appropriate.
[2]Seasonal test not required if seasonal conditions can be adequately simulated.
[3]Refer to Special Procedures

E. Special Procedures or Conditions
   1. None

F. Required Monitoring
   1. All points listed below which are control system monitored points shall be trended by the controls contractor. Other points shall be monitored by the CxA using dataloggers. Refer to the Monitoring section at paragraph 3.22.C for additional monitoring details

Point	Time Step (min.)	Minimum Time Period of Trend

For each zone thermostat and space sensor and other critical areas, monitor:		
Space temperature (summer design)	10	7 days
Space temperature (winter design)	10	7 days
Heating coil valve/heating command	10	7 days
Damper position and cfm	10	7 days

G. Acceptance Criteria
   1. For the conditions, sequences and modes tested, the TU, integral components and related equipment respond to varying loads and changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.
   2. Space temperature during occupied modes shall average within +/- 1°F of setpoint and always remain within 1°F of the ends of the deadband without excessive hunting of either the damper or coil valve/heating demand, or complaints of drafts or stuffiness from occupants.

   END OF REQUIREMENTS FOR TERMINAL UNIT TEST

3.25 TEST AND BALANCE WORK (TAB):
A. Parties Responsible to Execute Functional Test
   1. TAB contractor: perform checks using test instruments.
   2. Controls contractor: operate the controls to activate the equipment.
   3. CxA: to witness, direct and document testing.
B. Integral Components or Related Equipment Being Tested
   1. TAB water-side
   2. TAB air-side
C. Prerequisites: The applicable prerequisite checklist items listed in paragraph 3.22.B shall be listed on each certificate of readiness form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the startup plan checklists previously completed by the installer, before the beginning of functional testing.
D. Purpose. The purpose of this test is to spot check the TAB work to verify that it was done in accordance with the contract documents and acceptable practice and that the TAB report is accurate.
E. The following tests and checks will be conducted. The following testing requirements are in addition to and do not replace any testing requirements elsewhere in this DIVISION.

Test or Check	Test Method

Test or Check	Test Method
1. A random sample of up to 10% the TAB report data shall be selected for verification (air velocity, air or water flow rate, pressure differential, electrical measurement, etc.). The original TAB contractor will execute the checks, witnessed by the commissioning authority. The TAB contractor will use the same test instruments as used in the original TAB work. A failure[1] of more than 10% of the selected items of a given system[2] shall result in the failure of acceptance of the system TAB report and the TAB contractor shall be responsible to rebalance the system in its entirety, provide a new system TAB report and repeat random verifications of the new TAB report. The random testing will include the verification of minimum outdoor air intake flows at minimum, maximum and intermediate total airflow rates for 50% of the air handlers. Other selected data to be verified will be made known upon day of testing.	Demonstration
2. Verify that final settings of all valves, dampers and other adjustment devices have been permanently marked by the TAB Contractor.	Demonstration
3. Verify that the air system is being controlled to the lowest possible static pressure while still meeting design loads, less diversity. This shall include a review of TAB methods, control setpoints established by TAB and a physical verification of at least one leg from fan to diffuser having all balancing dampers wide open and that during full cooling of all TUs taking off downstream of the static pressure sensor, the TU on the critical leg has its damper 90% or more open.	Demonstration
4. Verification that the water system is being controlled to the lowest possible pressure while still meeting design loads, less diversity. This shall include a review of TAB methods, control setpoints established by TAB and a physical verification of at least one leg from the pump to the coil having all balancing valves wide open and that during full cooling the cooling coil valve of that leg is 90% or more open.	Demonstration

[1]Failure of an item is defined as follows:
For air flow of supply and return: a deviation of more than 10% of instrument reading
For minimum outside air flow: 20% of instrument reading
For temperatures: a deviation of more than 1°F
For air and water pressures: a deviation of more than 10% of full scale of test instrument reading

[2]Examples of a "system" are: the air distribution system served by one air handler or the hydronic chilled water supply system served by a chiller or the condenser water system. Systems can be defined as smaller parts if inaccuracies in TAB work within the smaller defined system will have little or no impact on connected systems.

[3]Design cooling season, heating season or both. "Design" means within 5°F of season design or 95% of loading design. A blank cell denotes no special seasonal test is required and that test can be executed during any season, if condition simulation is appropriate.

F. Special Procedures or Conditions
   1. Rechecking shall be limited to either 10% of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

G. Required Monitoring
   1. None

H. Acceptance Criteria
   1. Provided in footnote to test table above.

END OF REQUIREMENTS FOR TAB TEST

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SECTION 23 09 23 - DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY:

A. University of Missouri Controls Specification.

B. This SECTION contains requirements for electric and digital control systems as indicated on the contract drawings.

C. Contractor is responsible for providing, installing and connecting all sensors, actuators, control valves, control dampers, electrical components and electrical wiring between these devices and up to the Direct Digital Controller (DDC).

D. CHWP, VAV, FCU, & EF Controllers - 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, conduit, etc.

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 ASSURANACE:

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. Conduit and Raceway:
1. Electrical Metallic Tubing: EMT and fittings shall conform to ANSI C80.3.
2. Surface Metal Raceway and Fittings: Wiremold 500, Ivory, or approved equal.
3. Flexible Metal Conduit: Indoors, per National Electric Code for connection to moving or vibrating equipment.
4. Liquidtight Flexible Conduit: Outdoors, per National Electric Code for connection to moving or vibrating equipment.

B. Control Valves: Provide factory fabricated 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) Hydronic control valves shall be pressure independent. High performing energy monitoring control valves may be considered depending on the project. The flow through the valve shall not vary more than +/- 5% due to system pressure fluctuations across the valve in the selected operating range. The control valve shall accurately control the flow from 1 to 100% full rated flow.
b) The valve bodies shall be of cast iron, steel or bronze and rated for 150 PSI working pressure. All internal parts shall be stainless steel, steel, Teflon, brass, or bonze.
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.

h) All PICV valves to have threaded brass caps over test ports, no plastic allowed.

C. Control Dampers: Ruskin CD-50 or approved equal.
   1. Provide dampers with parallel blades for 2- position control.
   2. Provide opposed blades for modulating control.
   3. Dampers shall be low leakage design with blade and edge seals.
   4. Provide multiple sections and operators as required by opening size and sequence of operations, as indicated on the contract drawings.

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.

G. Electronic Temperature Sensors and Transmitters:
   1. Chilled Water, Tower Water, Heating Hot Water, and Steam Temperature Sensors
      a) General: The RTD/Temperature Transmitter/Thermowell assembly shall come as a complete assembly from a single manufacturer. The Assembly shall be suitable for use in the accurate measurement of Chilled/Tower/Hot Water and steam temperatures in a mechanical room environment.
      b) Calibration: Each RTD must be match calibrated to the Transmitter via NIST traceable calibration standards. Results are to be programmed into the transmitter. Results are to be presented on report as after condition at the specified calibration points. Assembly shall not be approved for installation until Owner has received all factory calibration reports.
      c) RTD:
         (1) RTD type: 2-wire or 3-wire 100 ohm platinum class A
         (2) Outside Diameter: 0.25 inch
         (3) Tolerance: +/- 0.06% Type A
         (4) Stability: +/- 0.1 % over one year.
         (5) TCR: 0.00385 (ohm/ohm/^{o}C).
         (6) RTD shall be tip sensitive.

(7) Resistance vs. Temperature table for the RTD must be provided to the Owner.

d) Transmitter:
   (1) Transmitter shall be match calibrated to the RTD and assembled as a matched pair.
   (2) Type: 2 wire (loop powered)
   (3) Input: 2 or 3 wire 100 ohm platinum class A or class B RTD
   (4) Output: Output shall be a 4-20 mA signal linear to temperature
   (5) Calibrated Span:
      (a) Chilled Water: 30 ºF to 130 ºF.
      (b) Tower Water: 30 ºF to 130 ºF.
      (c) Hot Water: 100 ºF to 250 ºF.
      (d) Steam: 150 ºF to 450 ºF
   (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[length code]08-SL-8HN31,TT440-385U-S(30-130)F with calibration SMC(40,60)F
   (3) Tower Water: RAF185L-S4C[length code]08-SL-8HN31,TT440-385U-S(5130)F with calibration SMC(55,85)F
   (4) Hot Water: RAF185L-S4C[length code]08T2-SL-8HN31,TT440-385U-S(100-250)F with calibration SMC(140,180)F
   (5) Steam: RAT185H-S4C[length code]08T2-SL-8HN31,TT440-385U-S(150-450)F with calibration SMC(300,350)F

H. Occupant Override: Provide wall mounted occupant override button in locations shown on drawings.

I. Low Limit Controllers: Provide unit-mounted low limit controllers, of rod-and-tube type, with an adjustable set point and a manual reset. Capillary shall be of adequate length to hori-

zontally traverse face of cooling coil every 12". Multiple low limit controllers may be required for large coils. Controller shall have an extra set of contactors for connection to control panel for alarm status. Locate the thermostat case and bellows where the ambient temperature is always warmer than the set point.

1. Freeze Stats: Johnson Controls model A70HA-1 or approved equal.

J. Humidistats: Humidistats must be contamination resistant, capable of ±2% RH accuracy, have field adjustable calibration and provide a linear proportional signal.
   1. HD20K-T91 or equivalent.

K. Humidity High Limit
   1. Multi-function device that can function as a high limit or proportional override humidity controller, as stand-alone proportional controller, or a stand-alone two-position controller.
      a) Johnson Controls TRUERH HL-67N5-8N00P or approved equal.

L. Carbon Dioxide Sensor:
   1. Wall Mount: ACI Model ESENSE-R.
   2. Duct Mount: ACI Model ESENSE-D.

M. Fan/Pump Status: Status points for fan or pump motors with a VFD must be connected to the terminal strip of the VFD for status indication.
   Current switches: Current switches are required for fan and pump statuses that are not connected to a VFD. The switches must have an adjustable trip setpoint with LED indication and be capable of detecting broken belts or couplings. Units shall be powered by monitored line, UL listed and CE certified, and have a five year warranty.
   1. Kele, Hawkeye or approved equal.

N. Relays Used for Fan and Pump Start/Stop: Must have LED indication and be mounted externally of starter enclosure or VFD.
   1. Kele, RIBU1C or approved equal.

O. Power Supply Used to Provide Power to Contractor-Provided Control Devices: Shall have adjustable DC output, screw terminals, overload protection and 24 VAC and 24 VDC output.
   1. Kele, DCPA-1.2 or approved equal.

P. Pressure Differential Switch:
   1. Fans: NECC model DP222 or approved equal.

Q. Differential Pressure Transmitter: Provide units with linear analog 4-20mA output proportional to differential pressure, compatible with the Johnson METASYS Systems.
   1. Water: Units shall be wet/wet differential pressure capable of a bi-directional pressure range of +/- 50 psid. Accuracy shall be +/- 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 267, or approved equal.
      b) Shall be installed in control panel and piped 2/3 down the duct unless shown otherwise or approved by owners representative.

R. Building Static Pressure: Transducer shall utilize a ceramic capacitive sensing element to provide a stable linear output over the specified range of building static pressure. Transducer shall be housed in a wall-mounted enclosure with LCD display. Transducer shall have the following

capabilities:

1. Input Power: 24 VAC
2. Output: 0-10 VDC
3. Pressure Range: -0.25 to +0.25 inches w.g.
4. Display: 3-1/2 digit LCD, displaying pressure in inches w.g.
5. Accuracy: +/- 1.0% combined linearity and hysteresis
6. Temperature effect: 0.05% / deg C
7. Zero drift (1 year): 2.0% max
8. Zero adjust: Push-button auto-zero and digital input
9. Operating Environment: 0 to 140 deg F, 90% RH (non-condensing)
10. Fittings: Brass barbs, 1/8" O.D.
11. Enclosure: High-impact ABS plastic
12. Outside Air Sensor Pickup Port: UV stabilized thermoplastic or aluminum "can" enclosure to shield outdoor pressure sensing tube from wind effects. BAPI ZPS-ACC10- rooftop mount, wall mount, or equivalent.
13. Transducer shall be Veris Industries Model PXPLX01S, equivalent from Setra, or approved equal.

S. High Static Pressure Limit Switch: Provide pressure high limit switch to open contact in fan circuit to shut down the supply fan when the inlet static pressure rises above the set point. Provide with an adjustable set point, a manual reset button, 2 SPST (normally closed) contacts, and ¼" compression fittings.
   1. Kele model AFS-460-DDS, or approved equal.

T. Carbon Monoxide Sensor: 24 VDC powered, 3-wire, wall-mounted sensor with 4-20 mA output. Detection range shall be between 10 ppm and 200 ppm. Factory calibrated and able to be recalibrated in the field. Sensor to be equal to Calibration Technologies model CG-CO.

U. Nitrogen dioxide (NOx) Sensor: 24 VDC powered, wall-mounted sensor with 4-20mA output. Detection range shall be between 0 ppm and 10 ppm. The sensor shall be housed in an impact resistant, IP66 rated housing. Sensor shall have self-check capability and an LED to indicate sensor readiness; equal to Toxalert International model Tox-NO2.

V. AIRFLOW MEASUREMENT DEVICES
   1. Provide airflow measurement devices where indicated on the plans. Fan inlet measurement devices shall not be substituted for duct or plenum measurement devices indicated on the plans.
   2. Airflow measuring devices of the vortex shedding type, capable of continuously monitoring the airflow volume of the duct served and electronically transmitting a signal linear to the airflow volume, shall be provided where indicated. Airflow measuring devices shall be of the insertion type, or built into airflow control valves, as required, with the capability of measuring velocity over the full range of 350 to 7000 FPM. Devices shall consist of multiple velocity sensors, supported on insertion probe bars. Accutrol Vortek VTD, no substitutions.
   3. Individual airflow sensors shall be of rugged construction, and shall not require special handling during installation. Sensors shall be mounted on support bars, as required to achieve an equal area traverse. Standard materials shall be aluminum bars with aluminum and ABS sensors. Support bars over one foot in length shall be supported on both ends. Where utilized in corrosive air streams, sensors and support bars shall be manufactured of corrosion resistant CPVC and ABS.
      a) A single manufacturer shall provide both the airflow measuring probe(s) and transmitter at a given measurement location.

4. Duct and Plenum Sensor Probe Assemblies
   a) Sensor housings shall be mounted in an extruded, gold anodized, 6063 aluminum tube probe assembly. Thermistor probes shall be mounted in sensor housings using a waterproof marine grade epoxy resin. All wires within the aluminum tube shall be Kynar coated.
   b) The number of sensor housings provided for each location shall be as follows:

(1) Area (sq.ft.)	Sensors
<2	4
2 to <4	6
4 to <8	8
8 to <16	12
>=16	16

   c) Probe assembly mounting brackets shall be constructed of 304 stainless steel. Probe assemblies shall be mounted using one of the following options:
      (1) Insertion mounted through the side or top of the duct.
      (2) Internally mounted inside the duct or plenum.
      (3) Standoff mounted inside the plenum.
   d) The operating airflow range shall be 0 to 5,000 FPM unless otherwise indicated on the plans.
5. Fan Inlet Sensor Probe Assemblies
   a) Sensor housings shall be mounted on 304 stainless steel blocks.
   b) Mounting rods shall be field adjustable to fit the fan inlet and constructed of nickel plated steel.
   c) Mounting feet shall be constructed of 304 stainless steel.
   d) The operating airflow range shall be 0 to 10,000 FPM unless otherwise indicated on the plans.
6. Transmitters
   a) The transmitter shall have a 16 character alpha-numeric display capable of displaying airflow, temperature, system status, configuration settings and diagnostics. Configuration settings and diagnostics shall be accessed through a pushbutton interface on the main circuit board. Airflow shall be field configurable to be displayed as a velocity or a volumetric rate.
   b) The transmitter shall be capable of independently monitoring and averaging up to 16 individual airflow and temperature readings. The transmitter shall be capable of displaying the airflow and temperature readings of individual sensors on the LCD display.
   c) The transmitter shall have a power switch and operate on 24 VAC (isolation not required). The transmitter shall use a switching power supply fused and protected from transients and power surges.
   d) All interconnecting pins, headers and connections on the main circuit board, option cards and cable receptacles shall be gold plated.
   e) The operating temperature range for the transmitter shall be -20° F to 120° F. The transmitter shall be protected from weather and water.
   f) The transmitter shall be capable of communicating with the host controls using one of the following interface options:
      (1) Linear analog output signal: Field selectable, fuse protected and isolated, 0-10VDC and 4-20mA (4-wire).
      (2) RS-485: Field selectable BACnet-MS/TP, ModBus-RTU and Johnson Con-

trols N2 Bus.
(3) 10 Base-T Ethernet: Field selectable BACnet Ethernet, BACnet-IP, ModBus-TCP and TCP/IP.
(4) LonWorks Free Topology.

g) The transmitter shall have an infra-red interface capable of downloading individual sensor airflow and temperature data or uploading transmitter configuration data to a handheld PDA (Palm or Microsoft Pocket PC operating systems).

7. The measuring device shall be UL listed as an entire assembly.
8. The manufacturer's authorized representative shall review and approve placement and operating airflow rates for each measurement location indicated on the plans. A written report shall be submitted to the consulting mechanical engineer if any measurement locations do not meet the manufacturer's placement requirements.
9. Manufacturer
   a) Primary flow elements, sensors, meters and transducers shall be EBTRON, Inc. Model GTx116-P and GTx116-F or approved equal.
   b) The naming of any manufacturer does not automatically constitute acceptance of this standard product nor waive their responsibility to comply totally with all requirements of the proceeding specification.

W. Electrical Requirements: Provide electric-pneumatic switches, electrical devices, and relays that are UL-listed and of type which meet current and voltage characteristics of the project. All devices shall be of industrial/ commercial grade or better. Residential types will be rejected.
1. EP Switches: Landis & Gyr Powers, Inc. Series 265 - Junction Box Type or approved equal.
2. Relays: Relays shall have an LED status indicator, voltage transient suppression, Closed-Open-Auto switch, plastic enclosure, and color coded wires. Kele model RIBU1C or approved equal.

X. Room Differential Pressure Alarm System: Room differential pressure devices shall be TSI PresSura or equal by Anemostat or Tekair. Provide a unit outside of each patient isolation room, protective environment room, operating room and, and C-section room. Refer to the architectural floor plans for exact number of rooms. Provide unit with audible and visual alarm, digital display of room pressure differential, through-the-wall pressure sensor and transformer. Provide BacNet interface for device monitoring through the BAS. System accuracy shall be +/- 10% of pressure reading with range of +/- 0.2000" w.c. Output signal shall be: 4-20mA. The device shall be provided with a door switch and field adjustable timer to minimize nuisance alarm indication due to door opening.

Y. Magnetic Flowmeter for Chilled Water, Tower Water, Make Up Water:
1. The Magnetic Flowmeter flow tube and computer/transducer shall come as a complete system assembled by a single manufacturer. The flowmeter shall be suitable for use in the accurate measurement of Chilled Water flow, Cooling Tower Water flow, or Make Up water flow for process control and/or utility metering, in a mechanical room environment, with a Johnson Controls EMCS system.
2. The flowmeter shall consist of a pulsed DC electromagnetic coil incorporating Faraday's Law utilizing the flowing Water as the conductor. The flowmeter shall provide proper grounding for use in Schedule 40 steel pipe, Schedule 10S stainless steel pipe, or copper pipe as application requires.
3. The flowmeter element should be sized to maintain maximum accuracy over the flow range of the application while keeping flow tube velocity below 15 fps at max flow. The

flowmeter element shall be the flow tube, spool piece type with a non-conductive lining and no intrusions into the flow path. The flowmeter flow tube shall be suitable for direct mounting to standard ANSI flanges.

4. The flowmeter shall have a local LCD display that indicates flow in GPM and/or Total gallons from the totalizer. The flowmeter shall be programmable/configurable via local push buttons. The flowmeter computer/transducer shall be remote mounted. The flow tube shall have a direct mounted junction box for wiring connections.
5. The flowmeter shall have the capability to be calibrated inside to verify proper operation and accuracies.
6. The flowmeter shall also meet the following specifications:
   a) Measures Bi-directional flow.
   b) Zero-point stability.
   c) Flow tube can withstand a full vacuum on an intermittent basis.
   d) Normal obstructions, partially opened valves, 90^0 or 45^0 elbows, and pump discharges shall require no more than 5 pipe diameters upstream and 3 pipe diameters downstream of straight pipe run for specified performance.
   e) Auto re-start after electrodes have lost wetness.
   f) Computer/transducers shall be interchangeable to multiple flow tubes without affecting the published accuracies of the meter.
   g) Computer/transducer internal electronic components, including power supply and output boards, shall be field interchangeable/exchangeable.
   h) Calibration: NIST Traceable, certificate provided with each meter.
   i) Electrode Pressure Rating: Equivalent to flow tube flange rating
   j) Minimum Conductivity: 5 mS/cm for fluid to be measured
   k) Transmitter Ambient Temp.: 122 ^{0}F
   l) Flow Tube Process Temp.: 32 ^{0}F to 140 ^{0}F for Chilled Water applications
   m) Flow Tube Process Temp.: 32 ^{0}F to 140 ^{0}F for Make Up Water applications
   n) Flow Tube Process Temp.: 32 ^{0}F to 311 ^{0}F for Hot or Dual Water applications
   o) Flow Range: +/- 0 to 30 fps
   p) Accuracy (velocity < /= 1.0 fps): +/- 0.5% of reading or +/- 0.005 fps
   q) Accuracy (velocity > 1.0 fps): +/- 0.5% of reading
   r) Analog Output: 4-20 mA, linear to flow in GPM
   s) Analog Output Accuracy: +/- 0.05% of span
   t) Repeatability: +/- 0.1%
   u) Stability: +/- 0.1%
   v) Ambient Temperature Effect: <1% per 100 ^{0}F
   w) Vibration Effect: 0.1% (remote mounted transducer)
   x) Low Flow Cutoff: settable to 0.04 fps or lower
   y) Low Flow Cutoff Analog Output: Analog output shall be 4.0 mA at flows below the low cutoff.
   z) Humidity Limits: 5-90% RH
   aa) Power Supply: 115 VAC
   bb) Power Consumption: 20 W maximum
   cc) Enclosures: NEMA 4
   dd) Flow Tube working pressure: 150 psi
   ee) Flanges: Carbon steel, ANSI Class 150#
   ff) Electrodes: Corrosion resistant Alloy C
   gg) Cable Length: As required per plans, 150 ft minimum

hh) Cable shall be capable of empty pipe detection.
ii) All cable shall be provided by the meter manufacturer.

7. The flowmeter shall be Foxboro IMT31A with 9500A, 9700A for high temperature, or approved equal.
8. Bids/Submittals: All bids and/or submittals must include published specifications, specific model number configurations, and operation & maintenance manuals.
9. Warranty: All parts and components as needed for the specified operation and performance shall be covered under warranty for a period of not less than two years.

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, descripted 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, descripted 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 where ever possible. Surface raceway may only be used with approval of Owners Representative. Wall mounted sensors such as CO2, RH, and non-adjustable temperature sensors shall be mounted 54" above finished floor. Duct mounted sensors shall be provided with mounting brackets to accommodate insulation. Mounting clips for capillary tubes for averaging sensors are required.
   2. All control devices shall be tagged and labeled for future identification and servicing of control system.
   3. Preheat and mixed air discharge sensors must be of adequate length and installed with capillary tube horizontally traversing face of coil, covering entire coil every 24 inches bottom to top.
   4. All field devices must be accessible or access panels must be installed.
   5. Carbon monoxide sensors are to be mounted approximately 50" above floor. Nitrogen dioxide sensors are to be mounted approximately 42" to 46" inches above floor.

   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. 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.
5. VAVs
   a) After the air handlers are running and under static pressure control and the heating water system is operating, and contractor has completed programming and checkout, Owner will test VAVs for proper operation and report any deficiencies.
6. Exhaust Systems
   a) Exhaust fans need to be operational and under control before labs can be commissioned.
7. Air Controls
   a) Air Controls vendor will have the same requirements as stated above for VAVs.
8. 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 23 09 23

SECTION 23 21 13 – HYDRONIC 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.

1.02 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 and heat recovery-water piping.
   4. Makeup-water piping.
   5. Condensate-drain piping.
   6. Air-vent piping.
   7. Safety-valve-inlet and -outlet piping.

1.03 RELATED REQUIREMENTS:

1. SECTION 07 84 13 – PENETRATION FIRESTOPPING
2. SECTION 23 21 23 - HYDRONIC PUMPS for pumps, motors, and accessories for hydronic piping.

1.04 REFERENCE STANDARDS:

A. Applicable Standards (Latest Edition):
   1. American Welding Society (AWS):
      a. A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
      b. D.1/D1.1M - Structural Welding Code - Steel.
      c. Brazing Handbook.
   2. International Mechanical Code with Missouri Amendments.
   3. ASME International (ASME):
      a. B1.20.1 - Pipe Threads, General Purpose, Inch.
      b. B16.1 - Cast-Iron Pipe Flanges and Flanged Fittings.
      c. B16.3 - Malleable Iron Threaded Fittings.
      d. B16.4 - Cast Iron Threaded Fittings.
      e. B16.5 - Pipe Flanges and Flanged Fittings, NPS 1/2 to NPS 24.
      f. B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.
      g. B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
      h. B16.39 - Malleable Iron Threaded Pipe Unions.
      i. B18.2.1 - Square and Hex Bolts and Screws - Inch Series.
      j. B31 - Code for Pressure Piping.
      k. B31.9 - Building Services Piping.
      l. Boiler and Pressure Vessel Code: Section IV, "Heating Boilers;" Section VIII, "Pressure Vessels," Division 1; Section IX, "Welding and Brazing Qualifications."
   4. ASTM International (ASTM):
      a. A47/A47M - Ferritic Malleable Iron Castings.
      b. A53/A53M - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      c. A106 - Seamless Carbon Steel Pipe for High-Temperature Service.

d. A126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
e. A234/A234M - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Services.
f. A307 - Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
g. A536 - Ductile Iron Castings.
h. A733 - Welded and Seamless Carbon Steel and Austenitic Stainless-Steel Pipe Nipples.
i. B32 - Solder Metal.
j. B75 - Seamless Copper Tube.
k. B75M - Seamless Copper Tube.
l. B88 - Seamless Copper Water Tube.
m. B88M - Seamless Copper Water Tube.
n. B306 - Copper Drainage Tube (DWV).
o. B584 - Copper Alloy Sand Castings for General Applications.
p. B813 - Liquid and Paste Fluxes for Solder Applications of Copper and copper Alloy Tube.
q. B828 - Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.

5. Copper Development Association, Inc. (CDA):
   a. Copper Tube Handbook.
6. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):
   a. SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture.
   b. SP-107 - Transition Union Fittings for Joining Metal and Plastic Products.
   c. SP-122 - Plastic Industrial Ball Valves.

1.05 DEFINITIONS:

A. PTFE: Polytetrafluoroethylene.

1.06 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: 150psig at 200ºF .
   2. Chilled-Water Piping: 150 psig at 200ºF.
   3. Glycol Cooling-Water Piping: 150 psig at 150ºF .
   4. Makeup-Water Piping: 80 psig at 150ºF.
   5. Condensate-Drain Piping: 150ºF.
   6. Blowdown-Drain Piping: 200ºF.
   7. Air-Vent Piping: 200ºF.
   8. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

1.07 SUBMITTALS:

A. Product Data: For each type of the following:
   1. Pressure-seal fittings.
   2. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
   3. Air control devices.
   4. Chemical treatment.

5. Hydronic specialties.

B. Shop Drawings: Detail, at 1/4 scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

C. Qualification Data: For Installer.

D. Welding certificates.

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.

G. Maintenance Material Submittals:

1. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

1.08 QUALITY ASSURANCE:

A. Installer Qualifications:

1. Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."

2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, DIVISION 1.

PART 2 - PRODUCTS

2.01 COPPER TUBE AND FITTINGS:

A. Drawn-Temper Copper Tubing: ASTM B88, Type L (ASTM B88M, Type B).

B. DWV Copper Tubing: ASTM B306, Type DWV.

C. Wrought-Copper Fittings: ASME B16.22.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Anvil International, Inc.

b. S. P. Fittings; a division of Star Pipe Products.

2.02 STEEL PIPE AND FITTINGS:

A. Steel Pipe: ASTM A53/A53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article.
D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article.
E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; flat ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.
F. Wrought-Steel Fittings: ASTM A234/A234M, wall thickness to match adjoining pipe.
G. Wrought Cast- and Forged-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 and flat face. Flat face forged steel flanges shall be used to connect to all classes of cast iron flange.
H. Pipe Nipples: All pipe nipples are to be SCH 80.

2.03 JOINING MATERIALS:

A. 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 (3.2 mm) 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.
B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
C. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.
D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
E. Welding Filler Metals: Comply with ASME Section IX for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
F. Gasket Material:
   1. Chilled Water and Glycol Systems: Garlock 22 red rubber gasket, no exceptions
   2. Heating How Water Systems: Garlock 9800 high temperature gasketing or Flexitallic, Flexicarb style CG gasket.

2.04 TRANSITION FITTINGS:

A. Plastic-to-Metal Transition Fittings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Charlotte Pipe and Foundry Company.
      b. IPEX, Inc.
      c. KBi.
   2. CPVC and PVC one-piece fitting with one threaded brass or copper insert and one Schedule 80 solvent-cement-joint end.
B. Plastic-to-Metal Transition Unions:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Charlotte Pipe and Foundry Company.
      b. IPEX, Inc.

c. KBi.
d. NIBCO INC.

2. MSS SP-107, CPVC and PVC union. Include brass or copper end, Schedule 80 solvent-cement-joint end, rubber gasket, and threaded union.

2.05 DIELECTRIC FITTINGS:

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Waterways:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Clearflow.
b. Victaulic Company.
2. Description:
a. Standard: IAPMO PS 66
b. Electro-zinc-plated steel nipple, complying with ASTM F1545.
c. Pressure Rating: 300 psig (2070 kPa) at 225ºF (107ºC) End Connections: Male threaded or grooved.
d. Lining: Inert and noncorrosive, NSF/FDA listed

2.06 VALVES:

A. Gate, Check, Ball, and Butterfly Valves: Comply with requirements specified in DIVISION 23, Section "General-Duty Valves for HVAC Piping."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in DIVISION 23, SECTION "INSTRUMENTATION AND CONTROL FOR HVAC."

C. Bronze, Calibrated-Orifice, Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Armstrong Pumps, Inc.
b. Bell & Gossett Domestic Pump; a division of ITT Industries.
c. Flow Design, Inc.
d. Griswold Controls.
e. Taco.
2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Plug: Resin.
5. Seat: PTFE.
6. End Connections: Threaded or socket.
7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Lever, with memory stop to retain set position.
9. CWP Rating: Minimum 125 psig (860 kPa).
10. Maximum Operating Temperature: 250ºF (121ºC).
11. Test ports to extend beyond insulation thickness

D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Armstrong Pumps, Inc.

b. Bell & Gossett Domestic Pump; a division of ITT Industries.
c. Flow Design, Inc.
d. Griswold Controls.
e. Taco.
f. Tour & Andersson; available through Victaulic Company.

2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Stem Seals: EPDM O-rings.
5. Disc: Glass and carbon-filled PTFE.
6. Seat: PTFE.
7. End Connections: Flanged or grooved.
8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
9. Handle Style: Lever, with memory stop to retain set position.
10. CWP Rating: Minimum 125 psig (860 kPa).
11. Maximum Operating Temperature: 250ºF (121ºC).
12. Test ports to extend beyond insulation thickness

E. Diaphragm-Operated, Pressure-Reducing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Amtrol, Inc.
b. Armstrong Pumps, Inc.
c. Bell & Gossett Domestic Pump; a division of ITT Industries.
d. Conbraco Industries, Inc.
e. Spence Engineering Company, Inc.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Low inlet-pressure check valve.
8. Inlet Strainer: <Insert materials>, removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

F. Diaphragm-Operated Safety Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Amtrol, Inc.
b. Armstrong Pumps, Inc.
c. Bell & Gossett Domestic Pump; a division of ITT Industries.
d. Conbraco Industries, Inc.
e. Spence Engineering Company, Inc.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.

5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Wetted, Internal Work Parts: Brass and rubber.
8. Inlet Strainer: Removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. 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.

G. Automatic Pressure Independent Flow-Control Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Flow Design, Inc.
   b. Griswold Controls.
   c. Hays Fluid Control.
2. Flow Control valves shall be factory set to rated flow. Each automatic balancing valve shall automatically control the flow rate to within ±5% of its rated flow, over a temperature range of 32ºF to 225ºF, and a pressure differential range of 2 to 80 psig. Valves shall have the capabilities and pressure ratings as indicated and conform to this specification.
3. Body: Brass or ferrous metal.
4. Flow Control Assembly shall be one of the following types;
   a. Piston and Spring Assembly: Stainless steel, tamper proof, self-cleaning, and removable.
   b. Precision sculptured brass or polyphenylsulfone orifice with an elastomeric diaphragm.
5. Combination Assemblies: Include bonze or brass-alloy ball valve.
6. Identification Tag: Marked with zone identification, valve number, and flow rate.
7. Size: Same as pipe in which installed.
8. Performance: Maintain constant flow, ±5% over system pressure fluctuations.
9. Minimum CWP Rating: 175 psig .
10. Maximum Operating Temperature: 200ºF.

2.07 AIR CONTROL DEVICES:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Amtrol, Inc.
2. Armstrong Pumps, Inc.
3. Bell & Gossett Domestic Pump; a division of ITT Industries.
4. Taco.

B. Manual Air Vents:
1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2 (DN 15).
5. Discharge Connection: NPS 1/8 (DN 6).
6. CWP Rating: 150 psig (1035 kPa).
7. Maximum Operating Temperature: 225ºF (107ºC).

C. Automatic Air Vents:

1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
3. Operator: Noncorrosive metal float.
4. Inlet Connection: NPS 1/2 (DN 15).
5. Discharge Connection: NPS 1/4 (DN 8).
6. CWP Rating: 150 psig (1035 kPa).
7. Maximum Operating Temperature: 240ºF (116ºC).

D. Expansion Tanks:

E. Diaphragm or Bladder-Type Expansion Tanks:
1. Tank: Welded steel, rated for 125 psig (860 kPa) working pressure and 375ºF (191ºC) maximum operating temperature. Factory test with taps fabricated and supports installed and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Diaphragm or Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
3. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

F. In-Line Air and Dirt Separators:
1. Tank: One-piece cast iron with an integral weir constructed to decelerate system flow to maximize air separation.
2. Maximum Working Pressure: Up to 175 psig (1207 kPa).
3. Maximum Operating Temperature: Up to 300ºF (149ºC).
4. Only Spirotherm will be acceptable manufacturer for chilled water. Glycol and Heating Hot water may use other manufactuters.

2.08 HYDRONIC PIPING SPECIALTIES:

A. Y-Pattern Strainers:
1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
3. Strainer Screen: [40] [60]-mesh startup strainer and perforated stainless-steel basket with 50% free area.
4. CWP Rating: 125 psig (860 kPa).

B. Basket Strainers:
1. Body: ASTM A126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
3. Strainer Screen: 40-mesh startup strainer and perforated stainless-steel basket with 50% free area.
4. CWP Rating: 125 psig (860 kPa).

C. T-Pattern Strainers:
1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: 40-mesh startup strainer and perforated stainless-steel basket with 57% free area.
4. CWP Rating: 750 psig (5170 kPa).

D. Stainless-Steel Bellow, Flexible Connectors:
   1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
   2. End Connections: Threaded or flanged to match equipment connected.
   3. Performance: Capable of 3/4 inch (20 mm) misalignment.
   4. CWP Rating: 150 psig (1035 kPa).
   5. Maximum Operating Temperature: 250ºF (121ºC).

E. Expansion fittings are specified in DIVISION 23, SECTION "EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING."

PART 3 - EXECUTION

3.01 PIPING APPLICATIONS:

ITEM	SIZE	DESCRIPTION
PIPE	All Sizes	Carbon steel, SCH 40, ASTM A53, Gr B.
PIPE	2-1/2" and smaller	Copper type L, ASTM B88.
Fittings	2-1/2" and smaller	Malleable iron, 150 pound Threaded, per ANSI B16.3
Fittings	2-1/2" and smaller	Copper, solder joint per ANSI B16.22.
Fittings	3" and larger	Carbon steel, buttweld type, long radius, SCH 40. Per ANSI B16.9
Unions	2" and Smaller	Malleable iron, Class 150 hexagonal stock with ball-and socket joints, bronze seating, ANSI B16.39
Flanges	2-1/2" and smaller	Bronze for copper pipe
Flanges	3" and larger	Forged steel, Class 150, Slip-on per ANSI 16.5

3.02 VALVE APPLICATIONS:

A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.
B. Install automatic balance valves (Auto Flo) at each branch connection to return main which does not use a pressure independent control valve.
C. Install check valves at each pump discharge and elsewhere as required to control flow direction.
D. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
E. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.03 PIPING INSTALLATIONS:

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such 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.

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 allow removal of valve by ladder or OSHA approved lifting device.
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. All heating hot water taps into reheat systems must come off the top of the pipe. Side and bottom connections are not allowed.
K. Select system components with pressure rating equal to or greater than system operating pressure.
L. Install groups of pipes parallel to each other, spaced to allow application of insulation and servicing of valves by ladder or OSHA approved lifting device.
M. Install drains, consisting of a tee fitting, NPS 3/4 (DN 20) ball valve, and short NPS 3/4 (DN 20) threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
P. Install valves according to SECTION 23 05 23 - GENERAL-DUTY VALVES FOR HVAC PIPING.
Q. Install unions in piping, NPS 2 (DN 50) and smaller only on outflow side of valve.
R. Install flanges in piping, NPS 2-1/2 (DN 65) and larger, at final connections of equipment and elsewhere as indicated.
S. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 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).
T. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in SECTION 23 05 16 - EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING.
U. Identify piping as specified in SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT.
V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in DIVISION 23, SECTION 23 05 17 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING.
W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in SECTION 23 05 17 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING.
X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in SECTION 23 05 18 - ESCUTCHEONS FOR HVAC PIPING.

3.04 HANGERS AND SUPPORTS:

A. Hanger, support, and anchor devices are specified in DIVISION 23, SECTION "HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT ". Comply with the following requirements for maximum spacing of supports.
   1. International Mechanical Code for minimum hanger spacing and sizing.

B. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal piping less than 20 ft. (6 m) long.
   2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 ft. (6 m) or longer.
   3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 ft. (6 m) or longer, supported on a trapeze.
   4. Spring hangers to support vertical runs.
   5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
   1. NPS 3/4 (DN 20): Maximum span, 7 ft. (2.1 m); minimum rod size, 1/4 inch (6.4 mm).
   2. NPS 1 (DN 25): Maximum span, 7 ft. (2.1 m); minimum rod size, 1/4 inch (6.4 mm).
   3. NPS 1-1/2 (DN 40): Maximum span, 9 ft. (2.7 m); minimum rod size, 3/8 inch (10 mm).
   4. NPS 2 (DN 50): Maximum span, 10 ft. (3 m); minimum rod size, 3/8 inch (10 mm).
   5. NPS 2-1/2 (DN 65): Maximum span, 11 ft. (3.4 m); minimum rod size, 3/8 inch (10 mm).
   6. NPS 3 (DN 80): Maximum span, 12 ft. (3.7 m); minimum rod size, 3/8 inch (10 mm).
   7. NPS 4 (DN 100): Maximum span, 14 ft. (4.3 m); minimum rod size, 1/2 inch (13 mm).
   8. NPS 6 (DN 150): Maximum span, 17 ft. (5.2 m); minimum rod size, 1/2 inch (13 mm).
   9. NPS 8 (DN 200): Maximum span, 19 ft. (5.8 m); minimum rod size, 5/8 inch (16 mm).
   10. NPS 10 (DN 250): Maximum span, 20 ft. (6.1 m); minimum rod size, 3/4 inch (19 mm).
   11. NPS 12 (DN 300): Maximum span, 23 ft. (7 m); minimum rod size, 7/8 inch (22 mm).
   12. NPS 14 (DN 350): Maximum span, 25 ft. (7.6 m); minimum rod size, 1 inch (25 mm).
   13. NPS 16 (DN 400): Maximum span, 27 ft. (8.2 m); minimum rod size, 1 inch (25 mm).
   14. NPS 18 (DN 450): Maximum span, 28 ft. (8.5 m); minimum rod size, 1-1/4 inches (32 mm).
   15. NPS 20 (DN 500): Maximum span, 30 ft. (9.1 m); minimum rod size, 1-1/4 inches (32 mm).

D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
   1. NPS 3/4 (DN 20): Maximum span, 5 ft. (1.5 m); minimum rod size, 1/4 inch (6.4 mm).
   2. NPS 1 (DN 25): Maximum span, 6 ft. (1.8 m); minimum rod size, 1/4 inch (6.4 mm).
   3. NPS 1-1/2 (DN 40): Maximum span, 8 ft. (2.4 m); minimum rod size, 3/8 inch (10 mm).
   4. NPS 2 (DN 50): Maximum span, 8 ft. (2.4 m); minimum rod size, 3/8 inch (10 mm).
   5. NPS 2-1/2 (DN 65): Maximum span, 9 ft. (2.7 m); minimum rod size, 3/8 inch (10 mm).
   6. NPS 3 (DN 80): Maximum span, 10 ft. (3 m); minimum rod size, 3/8 inch (10 mm).

E. Support vertical runs at roof, at each floor, and at 10 ft. (3 m) intervals between floors.

3.05 PIPE JOINT CONSTRUCTION:

A. Join pipe and fittings according to the following requirements and DIVISION 23 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 B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.
E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. 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/D10.12M, 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. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

3.06 HYDRONIC SPECIALTIES INSTALLATION:

A. Install manual air vents at high points in supply and return piping, at heat-transfer coils, and elsewhere as required for system air venting.
B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Manual vents at heat-transfer coils and elsewhere as required for air venting.
C. Install piping from heat exchanger outlet, air separator, or air purger to expansion tank with a 2% upward slope toward tank.
D. Install in-line air and dirt separators in pump suction. Install drain valve on air separators NPS 2 (DN 50) and larger.
E. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system Project requirements.

3.07 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.
C. Install ports for pressure gauges and thermometers at coil inlet and outlet connections according to SECTION 23 05 19 - METERS AND GAUGES FOR HVAC PIPING.

3.08 FIELD QUALITY CONTROL:

A. Prepare hydronic piping according to ASME B31.9 and as follows:
   1. Notify Owners Representative 24 hours before required testing. All tests shall be conducted in the presence of the Owners Representative.
   2. Flush system with clean water. Clean strainers.
   3. Minimum test pressure shall be 100 PSIG
   4. Pressure gauge shall be minimum 4” diameter face, 0-160 PSIG and shall be calibrated within one year of test date.
   5. Test pressure shall be held for one hour.
   6. Prepare reports for all tests and required corrective actions.

7. Clean and flush hydronic piping systems. Remove, clean and replace strainer screens. After cleaning and flushing hydronic piping system, but before balancing, remove disposable fine mesh strainers in pump suction diffusers.
8. System shall be operated for a minimum of 24 hours to demonstrate to the Owner's Representative that system is complete and operational.

B. 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.

END OF SECTION 23 21 13

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SECTION 23 21 23 – HYDRONIC PUMPS

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:
   1. Separately coupled, horizontally mounted, in-line centrifugal pumps.

1.03 REFERENCE STANDARDS:

A. Applicable Standards (Latest Edition):
   1. American National Standards Institute (ANSI):
      a. ANSI B15.1 - Safety Standard for Mechanical Power Transmission Apparatus.
   2. ASME International (ASME):
      a. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   3. ASTM International (ASTM):
      a. ASTM A36/A36M - Specification for Carbon Structural Steel.
      b. ASTM A53/A53M - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      c. ASTM B584 - Specification for Copper Alloy Sand Castings for General Applications.
   4. Hydraulic Institute (HI):
      a. HI 1.1-1.2 - Centrifugal Pumps for Nomenclature and Definitions (ANSI).
      b. HI 1.3 - Rotodynamic (Centrifugal) Pumps for Design and Application (ANSI).
      c. HI 1.4 - Centrifugal Pumps for Installation, Operation and Maintenance (ANSI).
      d. HI 2.1-2.2 - Vertical Pumps for Nomenclature and Definitions (ANSI).
      e. HI 2.3 - Vertical Pumps for Design and Application (ANSI).
      f. HI 2.4 - Vertical Pumps for Installation, Operation and Maintenance (ANSI).
   5. NFPA:
      a. NFPA 70 - National Electrical Code.
   6. Occupational Safety & Health Administration (OSHA):
      a. OSHA 1910.219 - Mechanical Power-Transmission Apparatus.

1.04 DEFINITIONS:

A. Buna-N: Nitrile rubber.
B. EPT: Ethylene propylene terpolymer.

1.05 SUBMITTALS:

A. Product Data: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.
B. Shop Drawings: For each pump.
   1. Show pump layout and connections.
   2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
   3. Include diagrams for power, signal, and control wiring.

4. Provide pump curve for variable speed pump showing efficiencies over operating range.

C. Closeout Submittals:
   1. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.06 MAINTENANCE:

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Mechanical Seals: One mechanical seal for each pump.

PART 2 - PRODUCTS

2.01 SEPARATELY COUPLED, VERTICALLY MOUNTED, IN-LINE CENTRIFUGAL PUMPS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Armstrong Pumps Inc.
   2. PACO Pumps.
   3. Xylem, Inc.; Bell & Gossett.
   4. TACO Incorporated.
   5. Peerless Pumps

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted vertically.

C. Pump Construction:
   1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet and companion-flange connections.
   2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For pumps not frequency-drive controlled, trim impeller to match specified performance.
   3. Pump Shaft: Stainless steel.
   4. Seal:
      a. Systems operating at or above 200ºF: Mechanical seal consisting of carbon rotating ring against a ceramic or silicon carbide seat held by a stainless-steel spring and bellows and gasket.
         (1) Bellows and Gasket:
            (a) All water systems operating below 250ºF: Buna-N.
            (b) Include water slinger on shaft between motor and seal.
      b. Systems operating below 200ºF: Packing seal consisting of stuffing box with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
   5. Pump Bearings:
      a. Systems operating below 160ºF: Regreasable bearings.
      b. Systems operating at or above 160ºF: Oil lubricated; bronze-journal or thrust type.

D. Shaft Coupling: TB Woods “Dura-flex” HP rated coupling

E. Motor: Single speed and rigidly mounted to pump casing with lifting eyebolt and supporting lugs in motor enclosure.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT.
3. Motor Bearings:
   a. Motors 5 HP and lower: Permanently lubricated.
   b. Motors greater than 5 HP: Regreasable bearings with minimum L10=200,000 hours
4. Efficiency: Premium efficient.

F. Capacities and Characteristics: Refer to equipment schedule on Contract Drawings.

2.02 AUTOMATIC AIR CONDITIONING CONDENSATE PUMP UNITS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Beckett Corporation.
   2. Hartell Pumps Div.; Milton Roy Co.
   3. Little Giant Pump Co.

B. Description: Packaged units with corrosion-resistant pump, ABS or polypropylene tank with cover, and automatic controls. Include factory- or field-installed check valve and a 72-inch minimum, electrical power cord with plug.

C. Capacities and Characteristics: See plans.

2.03 PUMP SPECIALTY FITTINGS:

A. Suction Diffuser:
   1. Angle pattern.
   2. 300-psig pressure rating, cast or ductile-iron body and end cap, pump-inlet fitting.
   3. Bronze startup and bronze or stainless-steel permanent strainers.
   4. Bronze or stainless-steel straightening vanes.
   5. Drain plug.
   6. Factory-fabricated support.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PUMP INSTALLATION:

A. Comply with HI 1.4 for centrifugal pumps.

B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
D. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.
E. Equipment mounting:
    1. Pumps Installed on Cast-in-Place Concrete Equipment Bases:
        a. Pumps without vibration isolation devices:
            (1) Install base-mounted pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases specified in DIVISION 03.
            (2) Coordinate sizes and locations of concrete bases with actual equipment provided.
            (3) Construct concrete bases 6 inches (150 mm) high and extend base not less than 6 inches (150 mm) in all directions beyond the maximum dimensions of base-mounted pumps, unless otherwise .
            (4) Minimum Compressive Strength: 5,000 psi (34.5 MPa) at 28 days.
            (5) Minimum equipment base weight is to be 5 times the weight of the pump or greater.
        b. Pumps with vibration isolation devices:
            (1) Install base-mounted pumps on cast-in-place concrete equipment base(s) using elastomeric pads . Comply with requirements for equipment bases specified in DIVISION 03. Comply with requirements for vibration isolation devices specified in SECTION 23 05 48 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT.
            (2) Minimum Deflection: 1/4 inch .
            (3) Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.
            (4) Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of concrete base.
            (5) For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
            (6) Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
            (7) Install anchor bolts to elevations required for proper attachment to supported equipment.
            (8) Install on 6-inch (150-mm) high concrete base designed to withstand
            (9) force required by code.
    2. Pumps Installed without Cast-in-Place Concrete Equipment Bases:
        a. Equipment Mounting: Install base-mounted pumps using elastomeric mounts. Comply with requirements for vibration isolation devices specified in SECTION 23 05 48 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT.
        b. Minimum Deflection: 1/4 inch .
    3. In-line Pumps:
        a. Do not suspend In-line pumps from structure, support weigh from piping only.
        b. Do not support pump motor
        c. Install pump shaft in horizontal plane
        d. Refer to drawings for In-Line pump mounting detail and further requirements

3.03 ALIGNMENT:

A. Engage a factory-authorized service representative to perform alignment service.
B. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.
C. Comply with pump and coupling manufacturers' written instructions.
D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.
E. Pump shall be aligned cold after grout has cured. Alignment of the pump shall be verified after the system is at operating temperature.

3.04 CONNECTIONS:

A. Comply with requirements for piping specified in SECTION 23 22 13 - STEAM AND CONDENSATE HEATING PIPING. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Where installing piping adjacent to pump, allow space for service and maintenance.
C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
E. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.
F. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or install single gage with multiple-input selector valve.
G. Install check valve and gate or ball valve on each condensate pump unit discharge.
H. Ground equipment according to DIVISION 26.
I. Connect wiring according to DIVISION 26.

3.05 STARTUP SERVICE:

A. Engage a factory-authorized service representative to perform startup service.
    1. Complete installation and startup checks according to manufacturer's written instructions.
    2. Check piping connections for tightness.
    3. Clean strainers on suction piping.
    4. Perform the following startup checks for each pump before starting:
        a. Verify bearing lubrication.
        b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
        c. Verify that pump is rotating in the correct direction.
    5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
    6. Start motor.
    7. Open discharge valve slowly.

3.06 DEMONSTRATION:

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION 23 21 23

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SECTION 23 25 00 – HVAC WATER TREATMENT

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 HVAC water treatment systems:
   1. Bypass chemical feed equipment

1.03 REFERENCES:

A. Applicable Standards (Latest Edition):
   1. American Water Works Association (AWWA):
      a. AWWA C606 - Grooved and Shouldered Joints.
      b. AWWA C700 - Cold-Water Meters - Displacement Type, Bronze Main Case.
      c. AWWA C701 - Cold-Water Meters - Turbine Type, for Customer Service.
   2. ASME International (ASME):
      a. ASME B.1.20.1 - Pipe Threads, General Purpose (Inch).
      b. ASME B16.5 - Pipe Flanges and Flanged Fittings.
      c. ASME Boiler and Pressure Vessel Code - Section VIII, "Pressure Vessels," Division 01; Section X, "Fiber-Reinforced Plastic Pressure Vessels."
   3. ASTM International (ASTM):
      a. ASTM A53/A53M - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      b. ASTM A126 - Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
      c. ASTM A269 - Specification for Seamless and Welded Austenitic Stainless-Steel Tubing for General Service.
      d. ASTM A276 - Specification for Stainless-Steel Bars and Shapes.
      e. ASTM A351 - Specification for Castings, Austenitic, Austenitic-Ferritic (Duplex), for Pressure-Containing Parts.
      f. ASTM A666 - Specification for Annealed or Cold-Worked Austenitic Stainless-Steel Sheet, Strip, Plate, and Flat Bar.
      g. ASTM A815/A815M - Specification for Wrought Ferritic, Ferritic/Austenitic, and Martensitic Stainless-Steel Piping Fittings.
      h. ASTM B88 - Specification for Seamless Copper Water Tube.
      i. ASTM B148 - Specification for Aluminum-Bronze Sand Castings.
      j. ASTM B584 - Specification for Copper Alloy Sand Castings for General Applications.
      k. ASTM D1068 -
   4. NFPA:
      a. NFPA 70 - National Electrical Code.

1.04 PERFORMANCE REQUIREMENTS:

A. Install chemical bypass feeder system as described in this specification section and detailed on drawings. All chemicals and analysis are provided by owner.

1.05 ACTION SUBMITTALS:

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for the following products:
   1. Bypass feeders.

1.06 INFORMATIONAL SUBMITTALS:

A. Field quality control test reports.
B. Other Informational Submittals:
   1. Water Treatment Program: Provided by Owner
C. Passivation Confirmation Report: Verify passivation of galvanized-steel surfaces and confirm this observation in a letter to Architect.

1.07 MAINTENANCE SERVICE:

A. Scope of Maintenance Service: Provided by Owner

1.08 MANUAL CHEMICAL FEED EQUIPMENT:

A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch (89-mm) fill opening in the top, and NPS 3/4 (DN 20) bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.
   1. Capacity: 5 gal.
   2. Minimum Working Pressure: 125 psig.

PART 2 - EXECUTION

2.01 INSTALLATION:

A. Bypass Feeders: Install in closed hydronic systems, including hot water heating and glycol cooling, and equipped with the following:
   1. Install bypass feeder in a bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
   2. Install water meter in makeup water supply.
   3. .
   4. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below feeder inlet.
   5. Install a swing check on inlet after the isolation valve.

2.02 CONNECTIONS:

A. Piping installation requirements are specified in other DIVISION 23 SECTIONS. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to equipment to allow service and maintenance.
C. Make piping connections between HVAC water treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in SECTION 23 21 13 - HYDRONIC PIPING.
D. Install shutoff valves on HVAC water treatment equipment inlet and outlet. Metal general-duty valves are specified in SECTION 23 05 23 - GENERAL-DUTY VALVES FOR HVAC PIPING.
E. Refer to SECTION 22 11 19 - DOMESTIC WATER PIPING SPECIALTIES for backflow preventers required in makeup water connections to potable water systems.

2.03 FIELD QUALITY CONTROL:

A. Tests and Inspections:

1. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water treatment system.
2. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
3. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
4. 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 test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
5. Repair leaks and defects with new materials and retest piping until no leaks exist.

B. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 23 25 00

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SECTION 23 31 13 – METAL DUCTS

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:
   1. Single-wall rectangular ducts and fittings.
   2. Single-wall round and flat-oval ducts and fittings.
   3. Sheet metal materials.
   4. Duct liner.
   5. Sealants and gaskets.
   6. Hangers and supports.

1.03 RELATED REQUIREMENTS:

A. SECTION 23 05 93 - TESTING, ADJUSTING AND BALANCING FOR HVAC for testing, adjusting, and balancing requirements for metal ducts.

B. SECTION 23 33 00 - AIR DUCT ACCESSORIES for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.04 REFERENCE STANDARDS:

A. Applicable Standards (Latest Edition):
   1. American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI):
      a. ASCE/SEI 7 - Minimum Design Loads for Buildings and Other Structures.
   2. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
      a. ASHRAE 62.1 - Ventilation for Acceptable Indoor Air Quality (ANSI).
   3. American Society of Heating, Refrigerating and Air-Conditioning Engineers/Illuminating Engineering Society of North America (ASHRAE/IESNA):
      a. ASHRAE/IESNA 90.1 - Energy Standard for Buildings except Low-Rise Residential Buildings (ANSI).
   4. American Welding Society (AWS):
      a. AWS D1.1/D1.1M - Structural Welding Code - Steel.
      b. AWS D1.2/D1.2M - Structural Welding Code - Aluminum.
      c. AWS D9.1M/D9.1 - Sheet Metal Welding Code.
   5. ASTM International (ASTM):
      a. ASTM A36/A36M - Specification for Carbon Structural Steel.
      b. ASTM A480/A480M - Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
      c. ASTM A492 - Specification for Stainless Steel Rope Wire.
      d. ASTM A603 - Specification for Zinc-Coated Steel Structural Wire Rope.
      e. ASTM A653/A653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      f. ASTM A1008/A1008M - Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
      g. ASTM B209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
      h. ASTM B209M - Specification for Aluminum and Aluminum-Alloy Sheet and Plate

i. ASTM C518 - Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
j. ASTM C916 - Specification for Adhesives for Duct Thermal Insulation.
k. ASTM C920 - Specification for Elastomeric Joint Sealants.
l. ASTM C1071 - Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
m. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.
n. ASTM E488 - Test Methods for Strength of Anchors in Concrete and Masonry Elements.

6. National Air Duct Cleaners Association (NADCA):
   a. NADCA 1992 - Mechanical Cleaning of Non-Porous Air Conveyance System Components.
   b. NADCA ACR - Assessment, Cleaning and Restoration of HVAC Systems.
7. NFPA:
   a. NFPA 90A - Installation of Air Conditioning and Ventilating Systems (ANSI).
   b. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems (ANSI).
   c. NFPA 96 - Ventilation Control and Fire Protection of Commercial Cooking Operations (ANSI).
8. The North American Insulation Manufacturers Association (NAIMA):
   a. HVAC Air Duct Leakage Test Manual.
   b. HVAC Duct Construction Standards - Metal and Flexible.
   c. IAQ Guidelines for Occupied Buildings under Construction - Appendix G, Duct Cleanliness for New Construction Guidelines.
   d. UL 723 - Test for Surface Burning Characteristics of Building Materials.

1.05 PERFORMANCE/DESIGN CRITERIA:

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.06 SUBMITTALS:

A. Product Data: For each type of the following products:
   1. Liners and adhesives.
   2. Sealants and gaskets.

B. Shop Drawings:
   1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
   2. Factory- and shop-fabricated ducts and fittings.
   3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
   4. Elevation of top of ducts.
   5. Dimensions of main duct runs from building grid lines.
   6. Fittings.
   7. Reinforcement and spacing.

8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

C. Delegated-Design Submittal:
1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.

D. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:
a. Lighting fixtures.
b. Air outlets and inlets.
c. Speakers.
d. Sprinklers.
e. Access panels.
f. Perimeter moldings.

E. Welding Procedure Specification (WPS) and Welder Performance Qualification Record (WPQR)

F. Field quality-control reports.

1.07 QUALITY ASSURANCE:

A. Welding Qualifications: Qualify welding procedures, welders, and welding operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. Welding Qualifications: Qualify welding procedures, welders, and welding operators 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.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5, "Systems and Equipment" and Section 7, "Construction and System Start-Up."

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4, "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.01 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS:

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class, unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.02 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS:

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class, unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Lindab, Inc.
   b. McGill AirFlow, LLC.
   c. SEMCO Incorporated.
   d. Sheet Metal Connectors, Inc.
   e. Spiral Manufacturing Co., Inc.
   f. Murphy Co.

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 inches (in Diameter: Flanged.

D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 inches (2286 mm) in diameter with butt-welded longitudinal seams.
2. Fabricate flat-oval ducts larger than 72 inches (1830 mm) in width (major dimension) with butt-welded longitudinal seams.

E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.03 SHEET METAL MATERIALS:

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
1. Galvanized Coating Designation: G90.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Carbon-Steel Sheets: Comply with ASTM A1008/A1008M, with oiled, matte finish for exposed ducts.

D. Stainless-Steel Sheets: Comply with ASTM A480/A480M, Type 304, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

E. Aluminum Sheets: Comply with ASTM B209 (ASTM B209M) Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

F. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.
1. 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: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.04 SEALANT AND GASKETS:

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:
1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 4 inches (102 mm).
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch w.g. (2500 Pa), positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: -40 to +200ºF (-40 to +93ºC).

9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
11. Sealant 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."

C. Water-Based Joint and Seam Sealant:
1. Application Method: Brush on.
2. Solids Content: Minimum 65%.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch w.g. (2500 Pa), positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Solvent-Based Joint and Seam Sealant:
1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60%.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
9. VOC: Maximum 395 g/L.
10. Sealant 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."
11. Maximum Static-Pressure Class: 10-inch w.g. (2500 Pa), positive or negative.
12. Service: Indoor or outdoor.
13. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. Flanged Joint Sealant: Comply with ASTM C920.
1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealant 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."

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:
   1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch w.g. (0.14 L/s per sq. m at 250 Pa) and shall be rated for 10-inch w.g. (2500 Pa) static-pressure class, positive or negative.
   2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
   3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.05 HANGERS AND SUPPORTS:

A. Hanger Rods for Noncorrosive Environments: Zinc-plated steel rods and nuts.
B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A603.
E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A492.
F. Zinc-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
H. Trapeze and Riser Supports:
   1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
   2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
   3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.01 DUCT INSTALLATION:

A. Coordinate duct layout and duct accessory arrangement with drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated, unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," unless otherwise indicated.
C. Install round and flat-oval ducts in maximum practical lengths.
D. Install ducts with fewest possible joints.
E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
H. Install ducts to allow for full insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches (38 mm).
K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in SECTION 23 33 00 - AIR DUCT ACCESSORIES for fire and smoke dampers.
L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.02 INSTALLATION OF EXPOSED DUCTWORK:

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.03 DUCT SEALING:

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
    1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
    2. Outdoor, Supply-Air Ducts: Seal Class A.
    3. Outdoor, Exhaust Ducts: Seal Class C.
    4. Outdoor, Return-Air Ducts: Seal Class C.
    5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-inch w.g. (500 Pa) and Lower: Seal Class B.
    6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-inch w.g. (500 Pa): Seal Class A.
    7. Unconditioned Space, Exhaust Ducts: Seal Class C.
    8. Unconditioned Space, Return-Air Ducts: Seal Class B.
    9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-inch w.g. (500 Pa) and Lower: Seal Class C.
    10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-inch w.g. (500 Pa): Seal Class B.
    11. Conditioned Space, Exhaust Ducts: Seal Class B.
    12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.04 HANGER AND SUPPORT INSTALLATION:

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. 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 or for slabs more than 4 inches (100 mm) thick. These fasteners shall not be used to support ductwork larger than 24 inches square.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.
5. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches (610 mm) of each elbow and within 48 inches (1200 mm) of each branch intersection.

C. Hangers Exposed to View: Threaded rod and angle or channel supports.

D. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet (5 m).

E. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.05 CONNECTIONS:

A. Make connections to equipment with flexible connectors complying with SECTION 23 33 00 - AIR DUCT ACCESSORIES.

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.06 PAINTING:

A. Paint interior of metal ducts that are visible through large sidewall return grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in DIVISION 09 Painting Sections.

3.07 FIELD QUALITY CONTROL:

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:
   a. Supply Ducts with Pressure Class of 3.25-inch w.g. or Higher: Test representative duct sections totaling no less than 60% of total installed duct area for each designated pressure class.

b. Supply Ducts with a Pressure Class of 3-inch w.g. (500 Pa or Higher: Test representative duct sections totaling no less than 50 % of total installed duct area for each designated pressure class.
c. Return Ducts with a Pressure Class of 3-inch w.g. (750 Pa or Higher: Test representative duct sections totaling no less than 50 % of total installed duct area for each designated pressure class.
d. Exhaust Ducts with a Pressure Class of -2-inch w.g. or greater totaling no less than 100 % of total installed duct area for each designated pressure class.

e. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.

3. Test for leaks before applying external insulation.
4. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
5. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests for Systems Serving Clean Rooms / Milk Lab:
1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.
E. Prepare test and inspection reports.

3.08 DUCT CLEANING:

A. Clean new duct system serving Clean Room / Milk Lab Spaces before testing, adjusting, and balancing.
B. Use service openings for entry and inspection.
1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with SECTION 23 33 00 - AIR DUCT ACCESSORIES for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:
1. When venting vacuuming system inside the building, use HEPA filtration with 99.97% collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:
1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.

3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
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 coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
5. Provide drainage and cleanup for wash-down procedures.
6. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.09 START UP:

A. Air Balance: Comply with requirements in SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC.

3.10 DUCT SCHEDULE:

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
B. Supply and Relief Ducts:
1. Supply Ducts Connected to Fan Coil Units, Blower Coils, and Terminal Units; Relief ducts connected to air handling units:
a. Pressure Class: Positive w.g. 2-inch w.g. (500 Pa).
b. Minimum SMACNA Seal Class: C.
c. SMACNA Leakage Class for Rectangular: 24.
d. SMACNA Leakage Class for Round and Flat Oval: 12.
2. Supply Ducts Connected to penthouse Variable-Air-Volume Air-Handling Units:
a. Pressure Class: Positive 6-inch w.g. and greater
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 6.
d. SMACNA Leakage Class for Round and Flat Oval: 3.
e. Milk Lab ducts to be Seal Class: A
3. Supply Ducts Connected to Level 0, 1, 2 Variable-Air-Volume Air-Handling Units:
a. Pressure Class: Positive 3-inch w.g. and up to 3.99-inch w.g.
b. Minimum SMACNA Seal Class: B.
c. SMACNA Leakage Class for Rectangular: 12.
d. SMACNA Leakage Class for Round and Flat Oval: 6

C. Return and Outdoor Air Ducts:
   1. Ducts Connected to Fan Coil Units, Blower Coils, and Terminal Units :
      a. Pressure Class: Positive or negative 1-inch w.g. (250 Pa)w.g. .
      b. Minimum SMACNA Seal Class: C
      c. SMACNA Leakage Class for Rectangular: 24.
      d. SMACNA Leakage Class for Round and Flat Oval: 12.
   2. Ducts Connected to Air-Handling Units :
      a. Pressure Class: Return duct risers, penthouse return ducts, and return mains on 8th floor: Positive or negative 3-inch w.g.; Return ducts on floors 1 thru 7: Positive or negative 2-inch w.g.; Outdoor air: 2-inch w.g.
      b. Minimum SMACNA Seal Class: B.
      c. SMACNA Leakage Class for Rectangular: 12.
      d. SMACNA Leakage Class for Round and Flat Oval: 6.

D. Exhaust Ducts:
   1. Ducts Connected to Fans Exhausting ASHRAE 62.1, Class 1 Air:
      a. Pressure Class: Negative and up 2-inch w.g..
      b. Minimum SMACNA Seal Class: C if negative pressure, and A if positive pressure.
      c. SMACNA Leakage Class for Rectangular: 12.
      d. SMACNA Leakage Class for Round and Flat Oval: 6 .
   2. Ducts Connected to Isolation Exhaust Fans::
      a. Pressure Class: Negative 2-inch w.g. (from exhaust grilles to HEPA filter)
      b. Pressure Class: Negative 4-inch w.g. (between HEPA filter and exhaust fan inlet)
      c. Minimum SMACNA Seal Class: B.
      d. SMACNA Leakage Class: 6.

E. Intermediate Reinforcement:
   1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.
   2. Stainless-Steel Ducts:
      a. Exposed to Airstream: Match duct material.
      b. Not Exposed to Airstream: Match duct material.
   3. Aluminum Ducts: Aluminum.

F. Liner:
   1. See drawings for transfer duct locations requiring flexible elastomeric lining.

G. Elbow Configuration:
   1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
      a. Velocity 1,000 fpm (5 m/s) or Lower:
         (1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
         (2) Mitered Type RE 4 without vanes.
      b. Velocity 1,000 to 1,500 fpm (5 to 7.6 m/s):
         (1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
         (2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
         (3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
      c. Velocity 1,500 fpm (7.6 m/s) or Higher:
         (1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
         (2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.

(3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
   a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
   b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
   c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
   a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
      (1) Velocity 1,000 fpm (5 m/s) or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
      (2) Velocity 1,000 to 1,500 fpm (5 to 7.6 m/s): 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
      (3) Velocity 1,500 fpm (7.6 m/s) or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
   b. Round Elbows, 12 inches (305 mm) and Smaller in Diameter: Stamped or pleated.
   c. Round Elbows, 14 inches (356 mm) and Larger in Diameter: Standing seam.

H. Branch Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
   a. Rectangular Main to Rectangular Branch: 45-degree entry.
   b. Rectangular Main to Round Branch: Spin in.
2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90-Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
   a. Velocity 1,000 fpm (5 m/s) or Lower: 90-degree tap.
   b. Velocity 1,000 to 1,500 fpm (5 to 7.6 m/s): Conical tap.
   c. Velocity 1,500 fpm (7.6 m/s) or Higher: 45-degree lateral.

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SECTION 23 33 00 – AIR DUCT ACCESSORIES

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:
   1. Backdraft and pressure relief dampers.
   2. Barometric relief dampers.
   3. Manual volume dampers.
   4. Control dampers.
   5. Fire dampers.
   6. Combination fire and smoke dampers.
   7. Flange connectors.
   8. Duct silencers.
   9. Turning vanes.
   10. Remote damper operators.
   11. Duct-mounted access doors.
   12. Flexible connectors.
   13. Flexible ducts.
   14. Duct accessory hardware.

1.03 RELATED DOCUMENTS:

A. SECTION 23 37 23 - HVAC GRAVITY VENTILATORS for roof-mounted ventilator caps.
B. DIVISION 28 for duct-mounted fire and smoke detectors.

1.04 REFERENCE STANDARDS:

A. Applicable Standards (Latest Edition):
   1. Air Movement and Control Association International, Inc. (AMCA):
      a. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating (ANSI).
   2. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
      a. ASHRAE 62.1 - Ventilation for Acceptable Indoor Air Quality (ANSI).
   3. American Society of Heating, Refrigerating and Air-Conditioning Engineers/Illuminating Engineering Society of North America (ASHRAE/IESNA):
      a. ASHRAE/IESNA 90.1 - Energy Standard for Buildings except Low-Rise Residential Buildings (ANSI).
   4. ASTM International (ASTM):
      a. ASTM A480/A480M - Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
      b. ASTM A653/A653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      c. ASTM B209-07 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
      d. ASTM B209M-07 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric].
      e. ASTM B221-07 - Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

f. ASTM B221M-07 - Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes [Metric].
g. ASTM E84-09a - Test Method for Surface Burning Characteristics of Building Materials.
h. ASTM E477-06a - Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.

5. NFPA:
   a. NFPA 90A - Installation of Air Conditioning and Ventilating Systems (ANSI).
   b. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems (ANSI).
   c. NFPA 96 - Ventilation Control and Fire Protection of Commercial Cooking Operations.
6. North American Insulation Manufacturers Association (The) (NAIMA):
   a. NAIMA AH116 - Fibrous Glass Duct Construction Standards.
7. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
   a. HVAC Duct Construction Standards - Metal and Flexible
8. Underwriters Laboratories, Inc. (UL):
   a. UL 181 - Factory-Made Air Ducts and Air Connectors.
   b. UL 555 - Fire Dampers.
   c. UL 555C - Ceiling Dampers.
   d. UL 555S - Smoke Dampers.
   e. UL 1978 - Standard for Grease Ducts.
   f. Fire Resistance Directory.

1.05 SUBMITTALS:

A. Product Data: For each type of product.
   1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.
B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
   1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
      a. Special fittings.
      b. Manual volume damper installations.
      c. Control-damper installations.
      d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
      e. Duct security bars.
      f. Wiring Diagrams: For power, signal, and control wiring.
C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.
D. Source quality-control reports.
E. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

F. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fusible Links: Furnish quantity equal to 10% of amount installed.

PART 2 - PRODUCTS

2.01 ASSEMBLY DESCRIPTION:

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.02 MATERIALS:

A. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
   1. Galvanized Coating Designation: G90.
   2. Exposed-Surface Finish: Mill phosphatized.

B. Stainless-Steel Sheets: Comply with ASTM A480/A480M, Type 304, and having a No. 2 finish for concealed ducts and exposed ducts.

C. 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.

D. Extruded Aluminum: Comply with ASTM B221 (ASTM B221M), Alloy 6063, Temper T6.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.03 MANUAL VOLUME DAMPERS:

A. Standard, Steel, Manual Volume Dampers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. American Warming and Ventilating; a division of Mestek, Inc.
      b. McGill AirFlow, LLC.
      c. Nailor Industries, Inc.
      d. Pottorff.
      e. Ruskin Company.
   2. Standard leakage rating , with linkage outside airstream.
   3. Suitable for horizontal or vertical applications.
   4. Frames:
      a. Frame: Hat-shaped, 0.05 inch thick stainless steel.
      b. Mitered and welded corners.
      c. Flanges for attaching to walls and flangeless frames for installing in ducts.
   5. Blades:
      a. Multiple or single blade.
      b. Parallel- or opposed-blade design.
      c. Stiffen damper blades for stability.
      d. Galvanized or Stainless-steel, 0.064 inch thick. Match duct material.

6. Blade Axles: Galvanized steel or Stainless steel. Match duct material
7. Bearings:
    a. Molded synthetic.
    b. Dampers in ducts with pressure classes of 3-inch w.g. or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Tie Bars and Brackets: Galvanized steel.

B. Low-Leakage, Steel, Manual Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Air Balance, Inc.; a division of Mestek, Inc.
    b. American Warming and Ventilating; a division of Mestek, Inc.
    c. McGill AirFlow, LLC.
    d. Nailor Industries, Inc.
    e. Pottorff.
    f. Ruskin Company.
2. Comply with AMCA 500-D testing for damper rating.
3. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
4. Suitable for horizontal or vertical applications.
5. Frames:
    a. Hat shaped.
    b. 0.094 inch thick, galvanized sheet steel or 0.05 inch thick stainless steel. Match material with duct attached to damper.
    c. Mitered and welded corners.
    d. Flanges for attaching to walls and flangeless frames for installing in ducts.
6. Blades:
    a. Multiple or single blade.
    b. Parallel- or opposed-blade design.
    c. Stiffen damper blades for stability.
    d. Galvanized or Stainless, roll-formed steel, 0.064 inch thick. Match to duct material
7. Blade Axles: Stainless steel.
8. Bearings:
    a. Molded synthetic.
    b. Dampers in ducts with pressure classes of 3-inch w.g. or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
9. Blade Seals: Neoprene.
10. Jamb Seals: Cambered stainless steel.
11. Tie Bars and Brackets: Aluminum.
12. Accessories:
    a. Include locking device to hold single-blade dampers in a fixed position without vibration.

C. Remote, Steel, Electronic Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. American Warming and Ventilating; a division of Mestek, Inc.
    b. McGill AirFlow, LLC.
    c. Nailor Industries, Inc.
    d. Pottorff.

e. Ruskin Company.
f. Greenheck.
g. Metropolitan Air Technology; A Steelhead Corp Company.
h. United Enertech.

2. Standard leakage rating , with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:
   a. Frame: Hat-shaped, 0.05 inch thick stainless steel.
   b. Mitered and welded corners.
   c. Flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
   a. Multiple or single blade.
   b. Parallel- or opposed-blade design.
   c. Stiffen damper blades for stability.
   d. Galvanized or Stainless-steel, 0.064 inch thick. Match duct material.
6. Blade Axles: Galvanized steel or Stainless steel. Match duct material
7. Bearings:
   a. Molded synthetic.
   b. Dampers in ducts with pressure classes of 3-inch w.g. or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Tie Bars and Brackets: Galvanized steel.
9. Actuator:
   a. Factory-installed 9 volt actuator
10. Accessories:
    a. Provide two handheld remote damper controllers.
    b. Provide one 25ft plenum rated control cable per damper.
    c. Provide wall plate for termination of damper control cables. Maximum six (6) dampers per wall plate in finished spaces.
    d. Wall plates shall be labeled to identify the damper served. Contractor shall provide a record of the wall plate labeling and drawings identifying the corresponding damper locations.

D. Jackshaft:
1. Size: 0.5-inch 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.

E. Damper Hardware:
1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.04 CONTROL DAMPERS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American Warming and Ventilating; a division of Mestek, Inc.
2. Arrow United Industries; a division of Mestek, Inc.

3. Greenheck Fan Corporation.
4. McGill AirFlow, LLC.
5. Nailor Industries, Inc.
6. Pottorff.
7. Ruskin Company.

B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

C. Frames:
1. Hat shaped.
2. 0.094-inch thick, galvanized sheet steel or0.05-inch thick stainless steel. Match material to duct
3. Mitered and welded corners.

D. Blades:
1. Multiple blade with maximum blade width of 8 inches.
2. Opposed-blade design.
3. Galvanized-steel or Stainless steel. Match duct material.
4. 0.0747-inch thick dual skin.
5. Blade Edging: PVC.

E. Blade Axles: 1/2-inch diameter; stainless steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
1. Operating Temperature Range: From -40 to +200ºF.

F. Bearings:
1. Molded synthetic.
2. Dampers in ducts with pressure classes of 3-inch w.g. or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
3. Thrust bearings at each end of every blade.

2.05 FIRE DAMPERS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Arrow United Industries; a division of Mestek, Inc.
2. Greenheck Fan Corporation.
3. Nailor Industries, Inc.
4. Pottorff.
5. Ruskin Company.
6. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.

C. Closing rating to match static pressure class of installation duct location and minimum 2,000-fpm velocity.

D. Fire Rating: 1-1/2 hours.

E. Frame: Curtain type with blades outside airstream Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch (0.85-mm) thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
1. Minimum Thickness: No less than gauge of connecting duct or 16-gauge, whichever is thickest, and of length to suit application.

2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

G. Mounting Orientation: Vertical or horizontal as indicated.
H. Blades: Roll-formed, interlocking, 0.034-inch thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch thick, galvanized-steel blade connectors.
I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
J. Heat-Responsive Device: Replaceable, 212ºF rated, fusible links.

2.06 COMBINATION FIRE AND SMOKE DAMPERS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Air Balance, Inc.; a division of Mestek, Inc.
2. Greenheck Fan Corporation.
3. Nailor Industries, Inc.
4. Pottorff.
5. Ruskin Company.

B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.
C. Closing rating to match that of installation ducts location static pressure class and minimum 2,000-fpm velocity.
D. Fire Rating: 1-1/2 hours.
E. Frame: Hat-shaped, 16-gauge, galvanized sheet steel, with welded corners and mounting flange.
F. Heat-Responsive Device: EFL (Electric Fuse Link) 212ºF rated, fusible links.
G. Smoke Detector: Provide with optional Duct Smoke Detector and mount per manufacturer's installation instruction, with field wiring for connection from fire alarm relay.
H. Blades: Roll-formed, horizontal, interlocking0.034 inch thick, galvanized sheet steel.
I. Leakage: Class I class.
J. Rated pressure and velocity to exceed design airflow conditions.
K. Mounting Sleeve: Factory-installed, 0.05 inch thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.
L. Master control panel for use in dynamic smoke-management systems.
M. Damper Motors: two-position action.
N. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT.
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 SECTION 23 09 23 - DDC BMS HVAC AND PER DIVISION 26 SECTIONS.
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 inch by lbf and breakaway torque rating of 150 inch by lbf.

5. 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 -40ºF.
6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 inch by lbf and breakaway torque rating of 300 inch by lbf.
7. Electrical Connection: 115V, single phase, 60 Hz.

O. Accessories:
1. Auxiliary switches for signaling.
2. Test and reset switches mounted.
3. Remote test switch shall be mounted, with interconnecting wire and conduit between test switch and combination fire smoke damper, at location shown on HVAC device plans.

2.07 FLANGE CONNECTORS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
2. Nexus PDQ; Division of Shilco Holdings, Inc.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

2.08 TURNING VANES:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
2. Duro Dyne, Inc.
3. Elgen Manufacturing.
4. METALAIRE, Inc.
5. SEMCO, Incorporated.
6. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

E. Vane Construction: Single wall.

2.09 DUCT-MOUNTED ACCESS DOORS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American Warming and Ventilating; a division of Mestek, Inc.

2. Ductmate Industries, Inc.
3. Greenheck Fan Corporation.
4. McGill AirFlow, LLC.
5. Nailor Industries, Inc.
6. Pottorff.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
1. Door:
   a. Double wall, rectangular.
   b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
   c. Vision panel.
   d. Hinges and Latches: 1- by 1-inch butt or piano hinge and cam latches.
   e. Fabricate doors airtight and suitable for duct pressure class.
2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:
   a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
   b. Access Doors up to 18 Inches Square: Continuous and two sash locks.
   c. Access Doors up to 24 by 48 Inches: Continuous and two compression latches[with outside and inside handles].
   d. Access Doors Larger Than 24 by 48 Inches: Continuous and two compression latches with outside and inside handles.

C. Pressure Relief Access Door:
1. Door and Frame Material: Galvanized sheet steel.
2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.
3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
4. Factory set at 3.0- to 8.0-inch w.g.
5. Doors close when pressures are within set-point range.
6. Hinge: Continuous piano.
7. Latches: Cam.
8. Seal: Neoprene or foam rubber.
9. Insulation Fill: 1 inch thick, fibrous-glass or polystyrene-foam board.

2.10 DUCT ACCESS PANEL ASSEMBLIES:

Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
2. Flame Gard, Inc.
3. 3M.

B. Labeled according to UL 1978 by an NRTL.
C. Panel and Frame: Minimum thickness 0.0428-inch stainless steel.
D. Fasteners: Carbon or Stainless steel, material to match duct construction. Panel fasteners shall not penetrate duct wall.

E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2,000ºF.
F. Minimum Pressure Rating: 10-inch w.g., positive or negative.

2.11 FLEXIBLE CONNECTORS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ductmate Industries, Inc.
   2. Duro Dyne, Inc.
   3. Elgen Manufacturing.
   4. Ventfabrics, Inc.
   5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
B. Materials: Flame-retardant or noncombustible fabrics.
C. Coatings and Adhesives: Comply with UL 181, Class 1.
D. Metal-Edged Connectors: Factory fabricated with a fabric strip 5 3/4 inches wide attached to two strips of 2-3/4 inches wide, 0.028 inch thick, galvanized sheet steel or 0.032 inch (0.8 mm) thick aluminum sheets. Provide metal compatible with connected ducts.
E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
   1. Minimum Weight: 26 oz./sq. yd..
   2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inchin the filling.
   3. Service Temperature: -40 to +200ºF.
F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
   1. Minimum Weight: 24 oz./sq. yd..
   2. Tensile Strength: 530 lbf/inch (93 N/mm) in the warp and 440 lbf/inch in the filling.
   3. Service Temperature: -50 to +250ºF.
G. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.
   1. Minimum Weight: 14 oz./sq. yd..
   2. Tensile Strength: 450 lbf/inch in the warp and 340 lbf/inch in the filling.
   3. Service Temperature: -67 to +500ºF.
H. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
   1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
   2. Outdoor Spring Diameter: Not less than 80% of the compressed height of the spring at rated load.
   3. Minimum Additional Travel: 50% of the required deflection at rated load.
   4. Lateral Stiffness: More than 80% of rated vertical stiffness.
   5. Overload Capacity: Support 200% of rated load, fully compressed, without deformation or failure.
   6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
   7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.12 FLEXIBLE DUCTS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Flexmaster U.S.A., Inc.
   2. McGill AirFlow, LLC.
   3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
   4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.

B. Insulated, Flexible Duct: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
   1. Pressure Rating: 10-inch w.g. positive and 1.0-inch w.g. negative.
   2. Maximum Air Velocity: 4,000 fpm.
   3. Temperature Range: -20 to +210ºF.
   4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.

C. Flexible Duct Connectors:
   1. 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.
   2. Non-Clamp Connectors: Adhesive plus sheet metal screws.

2.13 DUCT ACCESSORY HARDWARE:

1. 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.
2. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install control 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. Install steel volume dampers in 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 and fire smoke dampers according to UL listing.

H. Connect ducts to duct silencers rigidly.

I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. At outdoor-air intakes and mixed-air plenums.
   2. At drain pans and seals.
   3. Downstream from control dampers, backdraft dampers, and equipment.

4. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
5. Control devices requiring inspection.
6. Elsewhere as indicated.

J. Install access doors that utilize duct static pressure for complete, leak-free seal.

K. Access Door Sizes:
1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 inches.
3. Head and Hand Access: 18 by 10 inches.
4. Head and Shoulders Access: 21 by 14 inches.
5. Body Access: 25 by 14 inches.
6. Body plus Ladder Access: 25 by 17 inches.

L. Label access doors according to SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT to indicate the purpose of access door.

M. Install flexible connectors to connect ducts to equipment.
1. No flexible duct to be installed upstream of VAV boxes.

N. For fans developing static pressures of 5-inch w.g. and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

O. Connect terminal units to supply ducts with sheet metal only, no flex allowed.

P. Connect diffusers or light troffer boots to ducts with maximum 6-feet lengths of flexible duct clamped or strapped in place.

Q. Connect flexible ducts to metal ducts with draw bands.

R. Install duct test holes where required for testing and balancing purposes.

S. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.02 FIELD QUALITY CONTROL:

A. Tests and Inspections:
1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 23 33 00

SECTION 23 34 23 – HVAC POWER VENTILATORS

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:
   1. Utility set fans.
   2. Centrifugal roof ventilators.
   3. In-line centrifugal fans,
   4. Propeller fans.

1.03 REFERENCE STANDARDS:

A. American Bearing Manufacturers Association (ABMA):
   1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings (ANSI).
   2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. Air Movement and Control Association International, Inc. (AMCA):
   1. AMCA 99 - Standards Handbook.
   2. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
   3. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data (ANSI).

C. Air Movement and Control Association International, Inc./American Society of Heating, Refrigerating and Air-Conditioning Engineers (AMCA/ASHRAE):
   1. AMCA 210/ASHRAE 51 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating (ANSI).

D. NFPA:
   1. NFPA 70 - National Electrical Code.

E. Underwriters Laboratories, Inc. (UL):
   1. UL 705 - Power Ventilators.
   2. UL 762 - Outline of Investigation for Power Roof Ventilators for Restaurant Exhaust Appliances.

1.04 PERFORMANCE REQUIREMENTS:

A. Project Altitude: Base fan-performance ratings on actual Project Site elevations.

1.05 SUBMITTALS:

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:
   1. Certified fan performance curves with system operating conditions indicated.
   2. Certified fan sound-power ratings.
   3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   4. Material thickness and finishes, including color charts.
   5. Dampers, including housings, linkages, and operators.
   6. Roof curbs.
   7. Fan speed controllers.

B. Shop Drawings: 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.
3. Color Chart: Provide standard Color chart to allow for reviewer to make final color selection for each exhaust fan, weather hood, and stack assembly.

C. Delegated-Design Submittal: For unit hangars and supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified Professional Engineer responsible for their preparation.
1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.

D. Field quality-control reports.

E. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.06 QUALITY ASSURANCE:

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

1.07 COORDINATION:

A. Coordinate size and location of structural-steel support members.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.08 MAINTENANCE:

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Belts: One set for each belt-driven unit.

PART 2 - PRODUCTS

2.01 UTILITY SET FANS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Aerovent; a division of Twin City Fan Companies, Ltd.
2. Hartzell Fan, Incorporated.
3. New York Blower Company (The).
4. PennBarry.

B. Housing: Fabricated of galvanized steel with side sheets fastened with a deep lock seam or welded to scroll sheets.

1. Housing Discharge Arrangement: Adjustable to eight standard positions.

C. Fan Wheels: Single-width, single inlet; welded to cast-iron or cast-steel hub and spun-steel inlet cone, with hub keyed to shaft.
   1. Blade Materials: Steel or Aluminum.
   2. Blade Type: Backward inclined or Airfoil.

D. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.

E. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings with ABMA 9, L10 of 100,000 hours.
   1. Extend grease fitting to accessible location outside of unit.

F. Belt Drives:
   1. Factory mounted, with final alignment and belt adjustment made after installation.
   2. Service Factor Based on Fan Motor Size: 1.5.
   3. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
   4. Belts: Oil resistant, non-sparking, and non-static; matched sets for multiple belt drives.
   5. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.

G. Accessories:
   1. Inlet and Outlet: Flanged.
   2. Companion Flanges: Rolled flanges for duct connections of same material as housing.
   3. Access Door: Gasketed door in scroll with latch-type handles.
   4. Weather Hoods: Weather resistant with stamped vents over motor and drive compartment for fans located outside.

H. Capacities and Characteristics: Refer to Fan Schedule on Drawings.

2.02 CENTRIFUGAL ROOF VENTILATORS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Aerovent; a division of Twin City Fan Companies, Ltd.
   2. Greenheck Fan Corporation.
   3. Hartzell Fan, Incorporated.
   4. PennBarry.

B. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
   1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains and grease collector.
   2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Belt Drives:
   1. Resiliently mounted to housing.
   2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
   3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
   4. Pulleys: Cast-iron, adjustable-pitch motor pulley.
   5. Fan and motor isolated from exhaust airstream.

E. Accessories:
   1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50%.
   2. Disconnect Switch: Non-fusible type, with thermal-overload protection outside fan housing, factory wired through an internal aluminum conduit.
   3. Bird Screens: Removable, 1/2-inch (13-mm) mesh, aluminum or brass wire.
   4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.

F. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch (40-mm) thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch (40-mm) wood nailer. Size as required to suit roof opening and fan base.
   1. Configuration: built-in raised cant and mounting flange.
   2. Overall Height12 inches.
   3. Metal Liner: Galvanized steel.

G. Capacities and Characteristics: Refer to Fan Schedule on Drawings.

2.03 IN-LINE CENTRIFUGAL FANS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Greenheck Fan Corporation.
   2. Hartzell Fan, Incorporated.
   3. PennBarry.

B. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

C. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.

D. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.

E. Accessories:
   1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50%.
   2. Companion Flanges: For inlet and outlet duct connections.

F. Capacities and Characteristics: Refer to Fan Schedule on Drawings.

2.04 PROPELLER FANS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Aerovent; a division of Twin City Fan Companies, Ltd.
   2. Hartzell Fan, Incorporated.
   3. PennBarry.
   4. Greenheck.

B. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly.

C. Steel Fan Wheels: Formed-steel blades riveted to heavy-gage steel spider bolted to cast-iron hub.

D. Fan Wheel: Replaceable, cast or extruded-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.

E. Fan Drive:
   1. Resiliently mounted to housing.

2. Statically and dynamically balanced.
3. Selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
4. Extend grease fitting to accessible location outside of unit.
5. Service Factor Based on Fan Motor Size: 1.4.
6. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
7. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
   a. Ball-Bearing Rating Life: ABMA 9, L10 of 100,000 hours.
8. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
9. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
10. Belts: Oil resistant, non-sparking, and non-static; matched sets for multiple belt drives.
11. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.

F. Accessories:
1. Gravity Shutters: Aluminum blades in aluminum frame; interlocked blades with nylon bearings.
2. Motor-Side Back Guard: Galvanized steel, complying with OSHA Specifications, removable for maintenance.
3. Wall Sleeve: Galvanized steel to match fan and accessory size.
4. Weathershield Front Guard: Galvanized steel with expanded metal screen.
5. Disconnect Switch: Non-fusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

G. Capacities and Characteristics: Refer to Fan Schedule on Drawings.

2.05 MOTORS:

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT.
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 DIVISION 26 SECTIONS.

B. Enclosure Type: Totally enclosed, fan cooled.

2.06 SOURCE QUALITY CONTROL:

A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Division 23 contractor is to install power ventilators with roof curbs level and plumb.

B. Support units using elastomeric mounts having a static deflection of 1 inch. Vibration- control devices are specified in SECTION 23 05 48 - VIBRATION AND SEISMIC CONTROLS for HVAC Piping and Equipment.

1. Secure vibration controls to concrete bases using anchor bolts cast in concrete base.

C. Install floor-mounted units on concrete bases. Concrete, reinforcement, and formwork requirements are specified in DIVISION 03.

D. Install floor-mounted units on concrete bases designed to withstand, without damage to equipment, force required by code. Concrete, reinforcement, and formwork requirements are specified in DIVISION 03.

E. Secure roof-mounted fans to roof curbs with cadmium-plated hardware.

F. Ceiling Units: Fans shall not be hung from ceiling or structure above.

G. Install units with clearances for service and maintenance.

H. Label units according to requirements specified in SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT.

3.02 CONNECTIONS:

A. Duct installation and connection requirements are specified in other DIVISION 23 SECTIONS. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in SECTION 23 33 00 - AIR DUCT ACCESSORIES.

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to DIVISION 26.

D. Connect wiring according to DIVISION 26.

3.03 FIELD QUALITY CONTROL:

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.

9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
D. Prepare test and inspection reports.

3.04 ADJUSTING:

A. Adjust damper linkages for proper damper operation.
B. Adjust belt tension.
C. Comply with requirements in SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC for testing, adjusting, and balancing procedures.
D. Replace fan and motor pulleys as required to achieve design airflow.
E. Lubricate bearings.

END OF SECTION 23 34 23

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SECTION 23 36 00 – AIR TERMINAL UNITS

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:
   1. Fan-powered air terminal units.
   2. Shutoff, single-duct air terminal units.
   3. Laboratory air single duct terminal valves

1.03 REFERENCE STANDARDS:

A. Applicable Standards (Latest Edition):
   1. Air-Conditioning & Refrigeration Institute (ARI):
      a. ARI 880 - Air Terminals.
   2. American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI):
      a. ASCE/SEI 7 - Minimum Design Loads for Buildings and Other Structures.
   3. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
      a. ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
      b. ASHRAE 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size (ANSI).
      c. ASHRAE 62.1 - Ventilation for Acceptable Indoor Air Quality (ANSI).
   4. ASTM International (ASTM):
      a. ASTM A492 - Specification for Stainless-Steel Rope Wire.
      b. ASTM A603 - Specification for Zinc-Coated Steel Structural Wire Rope.
      c. ASTM C1071 - Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
      d. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.
      e. ASTM E488 - Test Methods for Strength of Anchors in Concrete and Masonry Elements.
   5. National Electrical Manufacturers Association (NEMA):
      a. NEMA 250 - Enclosures for Electrical Equipment (1,000V Maximum).
   6. NFPA:
      a. NFPA 70 - National Electrical Code.
      b. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
   7. Sheet Metal and Air Conditioning Contractors' National Association:
      a. HVAC Duct Construction Standards - Metal and Flexible.
   8. Underwriters Laboratories, Inc. (UL):
      a. UL 181 - Factory-Made Air Ducts and Air Connectors.

1.04 PERFORMANCE REQUIREMENTS:

A. Refer to Drawings for capacity performance.

B. Structural Performance: Hangers and supports shall withstand the effects of gravity and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards".

1.05 SUBMITTALS:

A. Action Submittals:
   1. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories.
      a. Air terminal units.
      b. Liners and adhesives.
      c. Sealants and gaskets.
   2. Shop Drawings: For air terminal units. Include plans, elevations, sections, details, and attachments to other work.
      a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, control/interface panel orientation, method of field assembly, components, and location and size of each field connection.
      b. Wiring Diagrams: For power, signal, and control wiring.
      c. Hangers and supports, including methods for duct and building attachment and vibration isolation.
   3. Delegated-Design Submittal:
      a. Materials, fabrication, assembly, and spacing of hangers and supports.

B. Informational Submittals:
   1. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
      a. Ceiling suspension assembly members.
      b. Size and location of initial access modules for acoustic tile.
      c. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
   2. Field quality control reports.

C. Closeout submittals:
   1. 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 the following:
      a. Instructions for resetting minimum and maximum air volumes.
      b. Instructions for adjusting software set points.

D. Maintenance Material Submittals:
   1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   2.

1.06 QUALITY ASSURANCE:

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

PART 2 - PRODUCTS

2.01 PARALLEL FAN-POWERED AIR TERMINAL UNITS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Krueger.
   2. Nailor Industries, Inc.
   3. Price Industries.
   4. Titus.
   5. Tuttle & Bailey.
   6. Trane; a business of American Standard Companies.

B. Configuration: Volume-damper assembly and fan in parallel arrangement inside unit casing with control components inside a protective metal shroud.

C. Casing: 0.034-inch (0.85-mm) steel or 0.032-inch (0.8-mm) aluminum, single wall.
   1. Casing Lining: Adhesive attached, 1 inch (25 mm) thick, coated, fibrous-glass duct liner complying with ASTM C1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E84.
      a. Cover liner with nonporous foil.
      b. Cover liner with nonporous foil and perforated metal (C-Section rooms and Procedure Rooms).
   2. Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.
   3. Air Outlet: S-slip and drive connections.
   4. Access: 10” x 10” removable door located between air damper and reheat coil for access and cleaning, and to parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.
   5. Fan: Forward-curved centrifugal, located at plenum air inlet.
   6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Volume Damper: Galvanized steel with flow-sensing ring and peripheral gasket and self-lubricating bearings.
   1. Maximum Damper Leakage: ARI 880 rated, 2% of nominal airflow at 3-inch w.g. (750 Pa) inlet static pressure.
   2. Damper Position: See Sequences.

E. Velocity Sensors: Multipoint array with velocity sensors in cold- and hot-deck air inlets and air outlets.

F. Motor:
   1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT.
   2. Type: Electronically commutated motor.
   3. Fan-Motor Assembly Isolation: Rubber isolators.
   4. Efficiency: Premium efficient.

G. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
   1. Material: 1 inch, glass fiber treated with adhesive; having 80% arrestance and 5 MERV.

H. Attenuator Section: 0.034-inch (0.85-mm) steel or 0.032-inch (0.8-mm) aluminum sheet.

1. Lining: Adhesive attached, 1 inch (25 mm) thick, coated, fibrous-glass duct liner complying with ASTM C1071, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E84.
   a. Cover liner with nonporous foil.
   b. Cover liner with nonporous foil and perforated metal.
2. Lining: Adhesive attached, 3/4 inch (19 mm) thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E84.
3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

I. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm) and rated for a minimum working pressure of 200 psig (1,380 kPa) and a maximum entering-water temperature of 220ºF (104ºC). Include manual air vent and drain valve.
   1. Location: VAV box air outlet.

J. Factory-Mounted and -Wired Controls: Electrical components mounted in control box with removable cover. Incorporate single-point electrical connection to power source.
   1. Wiring Terminations: Fan and controls to terminal strip. Terminal lugs to match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized according to NFPA 70.
   2. Disconnect Switch: Factory-mounted, fuse type.

K. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.

L. Electric Controls: No control components required from manufacturer, all controls are provided and installed by BAS contractor. See Paragraphs J and K above, wire fan speed controller to terminal block.

2.02 SHUTOFF, SINGLE-DUCT AIR TERMINAL VALVES:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Krueger.
   2. Nailor Industries, Inc.
   3. Price Industries.
   4. Tuttle & Bailey.
   5. Titus.
   6. Trane; a business of American Standard Companies.

B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

C. Casing: 22-gauge minimum, single wall.
   1. Casing Lining: Adhesive attached, ½-inch thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E84.
   2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
   3. Air Outlet: S-slip and drive connections, size matching inlet size.

4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Regulator Assembly: System-air-powered bellows section incorporating polypropylene bellows for volume regulation and thermostatic control. Bellows shall operate at temperatures from 0 to 140ºF (-18 to +60ºC), shall be impervious to moisture and fungus, shall be suitable for 10-inch w.g. (2,500 Pa) static pressure, and shall be factory tested for leaks.

E. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
1. Maximum Damper Leakage: ARI 880 rated, 2% of nominal airflow at 3-inch w.g. (750 Pa) inlet static pressure.
2. Damper Position: Fail in place.

F. Attenuator Section: 0.034-inch (0.85-mm) steel or 0.032-inch (0.8-mm) aluminum sheet.
1. Lining: Adhesive attached, 3/4 inch (19 mm) thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E84.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

G. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), and rated for a minimum working pressure of 200 psig (1,380 kPa) and a maximum entering-water temperature of 220ºF (104ºC). Include manual air vent and drain valve.

H. Direct Digital Controls: No controls are to come with VAV box, see SECTION 23 09 23 – DDC BMS FOR HVAC for control system requirements.

2.03 SOURCE QUALITY CONTROL:

A. Factory Tests: Test assembled air terminal units according to ARI 880.
1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, and ARI certification seal.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

C. Install wall-mounted thermostats.

3.02 HANGER AND SUPPORT INSTALLATION:

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
1. Where practical, install concrete inserts before placing concrete.

2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches (100 mm) thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches (100 mm) thick.

C. Hangers Exposed to view: Threaded rod and angle or channel supports. 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 CONNECTIONS:

A. Install piping adjacent to air terminal unit to allow service and maintenance.
B. Hot-Water Piping: In addition to requirements in SECTION 23 21 13 - HYDRONIC PIPING, connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.
C. Minimum 3 diameters inlet duct length required between box inlet and branch duct connection.
D. Connect ducts to air terminal units according to SECTION 23 31 13 - METAL DUCTS
E. Make connections to air terminal units with flexible connectors complying with requirements in SECTION 23 33 00 - AIR DUCT ACCESSORIES.

3.04 IDENTIFICATION:

A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT for equipment labels and warning signs and labels.

3.05 FIELD QUALITY CONTROL:

A. Tests and Inspections:
1. .
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.

B. Air terminal unit will be considered defective if it does not pass tests and inspections.
C. Execute parafunctional test for terminal boxes per CX Agent requirements

3.06 STARTUP SERVICE:

A. Engage a factory-authorized service representative to perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
3. Verify that controls and control enclosure are accessible.
4. Verify that control connections are complete.
5. Verify that nameplate and identification tag are visible.
6. Verify that controls respond to inputs as specified.
7. Engage Phoenix controls for complete startup of lab airflow control systems.

3.07 DEMONSTRATION:

A. Factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION 23 36 00

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SECTION 23 37 13 – DIFFUSERS, REGISTERS, AND GRILLES

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:
   1. Rectangular and square ceiling diffusers.
   2. Louver face diffusers.
   3. Linear slot diffusers.
      Ceiling-integral continuous diffusers.
   4. Fixed face registers and grilles.
   5. Extended face high capacity laminar flow diffusers.

1.03 RELATED REQUIREMENTS:

A. DIVISION 08 for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.

B. SECTION 23 33 00 - AIR DUCT ACCESSORIES for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.04 REFERENCE STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. Applicable Standards (Latest Edition):
   1. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
      a. ASHRAE 70 - Method of Testing for Rating the Performance of Air Outlets and Inlets (ANSI).

1.05 SUBMITTALS:

A. Action Submittals:
   1. Product Data: For each type of product indicated, include the following:
      a. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
      b. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
   2. Samples for Initial Selection: For diffusers, registers, and grilles with factory-applied color finishes.

B. Informational Submittals:
   1. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
      a. Ceiling suspension assembly members.
      b. Method of attaching hangers to building structure.
      c. Size and location of initial access modules for acoustical tile.
      d. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
      e. Duct access panels.

2. Source quality-control reports.

PART 2 - PRODUCTS

2.01 DIFFUSERS, REGISTERS, AND GRILLES:

A. For all diffusers, registers, and grilles:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Krueger.
      b. Nailor Industries, Inc.
      c. Price Industries.
      d. Tuttle & Bailey.
      e. Titus.
   2. All products shall conform to the schedules.

2.02 SOURCE QUALITY CONTROL:

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:

A. Install diffusers, registers, and grilles level and plumb.
B. 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 practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.03 ADJUSTING:

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13

SECTION 23 82 19 - FAN COIL UNITS

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. Ductless fan coil units and accessories.
   2. Ducted fan coil units and accessories.

1.03 ACTION SUBMITTALS:

A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings:
   1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Include diagrams for power, signal, and control wiring.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Samples for Verification: For each type of fan coil unit indicated.

1.04 INFORMATIONAL SUBMITTALS:

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Suspended ceiling components.
   2. Structural members to which fan coil units will be attached.
   3. Method of attaching hangers to building structure.
   4. Size and location of initial access modules for acoustical tile.
   5. Items penetrating finished ceiling, including the following:
      a. Lighting fixtures.
      b. Air outlets and inlets.
      c. Speakers.
      d. Sprinklers.
      e. Access panels.
   6. Perimeter moldings.

B. Field quality-control reports.

C. Sample Warranty: For special warranty.

1.05 CLOSEOUT SUBMITTALS:

A. Operation and Maintenance Data: For fan coil units to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in SECTION 01 78 23 "OPERATION AND MAINTENANCE DATA," include the following:

a. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

1.06 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.

1.07 QUALITY ASSURANCE:

A. Comply with NFPA 70.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.08 COORDINATION:

A. Coordinate layout and installation of fan coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate size and location of wall sleeves for outdoor-air intake.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION:

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.

2.02 DUCTLESS FAN COIL UNITS:

A. Fan Coil Unit Configurations: Row split.

1. Number of Cooling Coils: One with two-pipe system.

B. Coil Section Insulation: 1-inch- thick, foil-covered, closed-cell foam complying with ASTM C1071 and attached with adhesive complying with ASTM C916.

1. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E84 by a qualified testing agency.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Coil Section Insulation: Insulate coil section according to SECTION 23 06 16 "HVAC EQUIPMENT INSULATION."

1. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E84 by a qualified testing agency.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Drain Pans: Stainless steel or plactic. Fabricate pans and drain connections to comply with ASHRAE 62.1

E. Chassis: Galvanized steel where exposed to moisture, with baked-enamel finish and removable access panel. Floor-mounting units shall have leveling screws.
F. Cabinet: Steel with baked-enamel finish in manufacturer's standard paint color as selected by Architect.
   1. Vertical Unit Front Panels: Removable, steel, with integral stamped discharge grille and channel-formed edges, cam fasteners, and insulation on back of panel.
   2. Horizontal Unit Bottom Panels: Fastened to unit with cam fasteners and hinge and attached with safety chain; with integral stamped discharge grilles.
   3. Stack Unit Discharge and Return Grille: Aluminum double-deflection discharge grille, and louvered- or panel-type return grille; color as selected by Architect from manufacturer's standard colors. Return grille shall provide maintenance access to fan coil unit.
   4. Steel recessing flanges for recessing fan coil units into ceiling or wall.
G. Filters: Minimum arrestance and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2 and all addendums.
   1. MERV Rating: 6 when tested according to ASHRAE 52.2.
H. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), rated for a minimum working pressure of 200 psig (1378 kPa) and a maximum entering-water temperature of 220 deg F (104 deg C). Include manual air vent and drain valve.
I. Fan and Motor Board: Removable.
   1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
   2. Motor: ECM motor, multispeed; resiliently mounted on motor board. Comply with requirements in SECTION 23 05 13 "COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT."
   3. Wiring Termination: Connect motor to chassis wiring with plug connection.
J. Control devices and operational sequences are specified in SECTION 23 09 23 "DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC" and SECTION 23 09 93.11 "SEQUENCE OF OPERATIONS FOR HVAC DDC."
K. Basic Unit Controls:
   1. All controls by BAS contractor.
L. Electrical Connection: Factory wire motors and controls for a single electrical connection.
M. Capacities and Characteristics:
   1. See Drawings

2.03 DUCTED FAN COIL UNITS:

A. Manufacturer basis of Design: Trane.
B. Fan Coil Unit Configurations: Row split.
   1. Number of Cooling Coils: One with two-pipe system.
C. Coil Section Insulation: 1-inch- thick, foil-faced glass fiber complying with ASTM C1071 and attached with adhesive complying with ASTM C916.
   1. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E84 by a qualified testing agency.

2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Coil Section Insulation: Insulate coil section according to SECTION 23 06 16 "HVAC EQUIPMENT INSULATION."
   1. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E84 by a qualified testing agency.
   2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

E. Drain Pans: Stainless steel. Fabricate pans and drain connections to comply with ASHRAE 62.1.

F. Chassis: Galvanized steel where exposed to moisture, with baked-enamel finish and removable access panel. Floor-mounting units shall have leveling screws.

G. Cabinets: Steel with baked-enamel finish in manufacturer's standard paint color.
   1. Supply-Air Plenum: Sheet metal plenum finished and insulated to match the chassis.
   2. Return-Air Plenum: Sheet metal plenum finished to match the chassis.

H. Filters: Minimum arrestance and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2 and all addendums.

I. MERV Rating: 6 when tested according to ASHRAE 52.2.

J. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), rated for a minimum working pressure of 200 psig (1378 kPa) and a maximum entering-water temperature of 220 deg F (104 deg C). Include manual air vent and drain.

K. Retain "Direct-Driven Fans" or "Belt-Driven Fans" Paragraph below. Retain both if multiple-type units are required. If retaining both, indicate fan type in the Fan Coil Unit Schedule on Drawings.

L. Direct-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels and painted-steel or galvanized-steel fan scrolls.
   1. Motors: Comply with requirements in SECTION 23 05 13 "COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT."

M. Belt-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the cabinet. Aluminum or painted-steel wheels and painted-steel or galvanized-steel fan scrolls.
   1. Motors: Comply with requirements in SECTION 23 05 13 "COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT."

N. Control devices and operational sequence are specified in SECTION 23 05 48 "VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT."

O. Basic Unit Controls:
   1. All controls by BAS contractor

P. Electrical Connection: Factory wire motors and controls for a single electrical connection.

Q. Capacities and Characteristics:
   1. See Drawings.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine areas, with Installer present, to receive fan coil units for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping and electrical connections to verify actual locations before fan coil unit installation.

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

3.02 INSTALLATION:

A. Install fan coil units level and plumb.

B. Install fan coil units to comply with NFPA 90A.

C. Install new filters in each fan coil unit within two weeks after Substantial Completion.

3.03 CONNECTIONS:

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:

1. Install piping adjacent to machine to allow service and maintenance.
2. Connect condensate drain to indirect waste.
    a. Install condensate trap of adequate depth to seal against fan pressure. Install cleanouts in piping at changes of direction.

B. Connect supply-air and return-air ducts to fan coil units with flexible duct connectors specified in SECTION 23 33 00 "AIR DUCT ACCESSORIES." Comply with safety requirements in UL 1995 for duct connections.

C. Ground equipment according to SECTION 26 05 26 "GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS."

D. Connect wiring according to SECTION 26 05 19 "LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES."

3.04 FIELD QUALITY CONTROL:

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.05 ADJUSTING:

A. Adjust initial temperature and humidity set points.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.06 DEMONSTRATION:

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fan coil units.

END OF SECTION 23 82 19

SECTION 26 05 10 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. This SECTION specifies general administrative and procedural requirements for electrical installations. The following administrative and procedural requirements are included in this SECTION to expand the requirements specified in DIVISION 01:
   1. Rough-ins.
   2. Electrical installations.
   3. Cutting and patching.
   4. Electrical Demolition.
   5. Touch-up Painting.
   6. Electrical service and distribution system switch-over.

1.02 RELATED REQUIREMENTS:

A. SECTION 23 05 13 – COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT for factory-installed motors, controllers, accessories, and connections.

1.03 REFERENCE STANDARDS:

A. National Fire Protection Association (NFPA): NFPA - 70 National Electrical Code (NEC).
B. Institute of Electrical and Electronics Engineers (IEEE): IEEE C2 National Electrical Safety Code (NESC).
C. Underwriters Laboratories (UL).
D. Federal Information Processing Standards Publication (FIPS).
E. National Electrical Contractors Association (NECA): National Electrical Installation Standards (NEIS): Except where the NEIS requirements specifically deviate from specific requirements of the NEC, the NEC shall take precedence.
F. All local codes and standards.

PART 2 - PRODUCTS

2.01 PRODUCTS:

A. Unless indicated otherwise, all equipment and material shall be new, undamaged and meet the requirements of Underwriters Laboratories, Inc. (UL). Where UL requirements are not applicable, equipment and material shall be identified as such by Contractor and approved by Owner before purchase and installation.

2.02 ELECTRONIC EQUIPMENT COMPLIANCE:

A. Contractor warrants that all equipment, devices, items, systems, software, hardware, or firmware provided shall properly, appropriately, and consistently function and accurately process date and time data (including without limitation: calculating, comparing, and sequencing). This warranty supersedes anything in the Specifications or other Contract Documents which might be construed inconsistently. This warranty is applicable whether the equipment, device, item, system, software, hardware, or firmware is specified with or without reference to a manufacturer's name, make, or model number.

2.03 FINISHES:

A. For equipment: Equipment manufacturer's paint selected to match installed equipment finish.

B. Galvanized surfaces: Zinc-rich paint recommended by item manufacturer.

PART 3 - EXECUTION

3.01 ELECTRICAL SERVICE AND DISTRIBUTION SYSTEM SWITCHOVER

A. Maintain existing electrical service, generators, feeders, chillers, air handlers and boilers for all occupied areas and operational facilities, unless otherwise indicated or when authorized otherwise in writing by Owner. Provide temporary service during interruptions to existing facilities. When necessary, schedule momentary outages to existing systems in accordance with the requirements for Interruption of Existing Electrical Service.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Owner no fewer than two weeks in advance of proposed interruption of electric service.
   2. Do not proceed with interruption of electric service without Owner's approval of a written outage plan, Method of Procedure, specific for the work being performed during the planned interruption of service.
   3. Do not proceed with interruption of electric service without Owner's written permission to proceed.

3.02 ERECTION, INSTALLATION, APPLICATION:

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. All electrical work and material shall comply with the following requirements:
   1. NFPA 70 - The National Electrical Code (NEC).
   2. IEEE C2, National Electrical Safety Code, Federal Information Processing Standards Publication (FIPS).
   3. NECA National Electrical Installation Standards (NEIS) (all except Table 1 of NECA 1).
   4. Coordinate electrical systems, equipment, and materials installation with other building components. Equipment motor horsepower sizes and kilowatt sizes shown are approximate. If equipment of a different size is furnished by Contractor, Contractor shall furnish and install the proper support equipment, motor starter, switchgear, feeders, fuses, circuit breaker, disconnect switch, wire, and conduit required for the equipment furnished, at no additional cost to Owner.
   5. Verify all existing dimensions by field measurements.
   6. Arrange for chases, slots, and openings in other building components during progress of construction to allow for electrical installations.
   7. 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.
   8. 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. Coordinate concrete pads, bases, and related items.
   9. Coordinate with all other building trades.
   10. Where mounting heights are not specifically detailed, specified, or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.

11. Coordinate connection of electrical systems with exterior utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
12. 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. Should coordination requirements conflict with individual system requirements, refer conflict to Owner's Representative in writing.
13. Install systems, materials, and equipment level, plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
14. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting with minimum of interference with other installations.
15. Install access panel or doors where units are concealed behind finished surfaces. The electrical contractor shall be responsible for furnishing access panels required for electrical equipment access. Access panels shall be installed by Contractor.
16. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
17. All equipment and materials shall be installed in accordance with NFPA 70 - The National Electrical Code (NEC).
18. All equipment conductor termination provisions shall be UL listed for 75ºC conductors.
19. All electrical equipment and installations shall be of adequate strength to withstand, without failure, forces encountered in defined Seismic conditions.
20. Install raceways, cables, wireways, cable trays and busways clear of obstructions and clear of the required working space of equipment.

C. Refer to each SECTION of this DIVISION for specific performance requirements.

3.03 DEMOLITION:

A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the work, remove damaged portions and install new products of equal capacity, quality, and functionality.
B. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.
C. Abandoned Work: Cut and remove buried raceway and wiring indicated to be abandoned in place, 2-inches below surface of adjacent construction. Cap raceways and patch surface to match existing surface finish.
D. Remove demolished material from project site.
E. Remove, store, clean, re-install, reconnect and make operational components indicated for relocation.
F. Disposal of existing fluorescent lamps shall be by Contractor shipping the lamps to an EPA approved recycler for recycling. All shipping and disposal costs will be paid by Contractor at no additional expense to Owner.

3.04 CUTTING AND PATCHING:

A. General: Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of the trades involved. Perform cutting and patching in accordance with SECTION 02 41 26 - CUTTING

AND PATCHING. In addition to the requirements specified in DIVISION 02, the following requirements apply:

1. Perform cutting and patching for 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. Upon written instructions from Engineer, uncover and restore work to provide for Engineer's observation of concealed work if installed without using the proper specified procedures.

B. For work in existing installations, the Contractor shall 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.

C. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

D. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas per Owner's infection control guidelines and procedures.

E. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

F. All penetrations through fire-rated walls, ceilings and floors shall be sealed with a U.L. listed and FM Global approved sealant system that matches the fire rating of the surface penetrated.

G. Patch existing finished surfaces and building components that must be cut for the electrical installation or are damaged by Contractor using new materials matching existing materials.

H. Patch finished surfaces and building components using new materials specified for the original installation.

I. All cutting, patching, and repairing shall be subject to the supervision and the approval of Owner's Representative.

J. Repair and re-finish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fire proofing where existing fireproofing has been disturbed. Repair and re-finish materials and other surfaces by skilled mechanics of trades involved.

3.05 FINISHES:

A. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit degree of damage at each location.

B. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.

C. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

D. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

E. Repair damage to protective coatings in accordance with manufacturer's recommendations.

3.06 CLEANING:

A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

3.07 PROTECTION:

A. Protect equipment and installations and maintain conditions to ensure that coatings, finishes and cabinets are without damage or deterioration at time of Substantial Completion.

3.08 CLOSEOUT:

A. Instructions, training, and manufacturer's service representative:
   1. Provide on-site instructions and training of Owner's personnel as specified.
   2. Provide on-site services of a manufacturer's authorized service representative as specified

END OF SECTION 26 05 10

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SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification SECTION, apply to this SECTION.

1.02 SUMMARY:

A. This SECTION includes the following:
   1. Building wires and cables rated 600V and less.
   2. Connectors, splices, and terminations rated 600V and less.

1.03 REFERENCE STANDARDS:

A. Applicable Standards (latest edition):
   1. ASTM International:
      a. ASTM B 3-13 – Specification for Soft or Annealed Copper Wire.
   2. Code of Federal Regulations (CFR):
      a. 29 CFR - Labor, Chapter XVII - Occupational Safety and Health Administration, Department of Labor, Part 1910 - "Occupational Safety and Health Standards," Sub"General," Section 1910.7 - "Definition and Requirements for a Nationally Recognized Testing Laboratory."
   3. The Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. IEEE 141 - Recommended Practice for Electric Power Distribution for Industrial Plants (the Red Book).
      b. IEEE 241 - Recommended Practice for Electric Power Systems in Commercial Buildings (the Gray Book).
   4. International Electrical Testing Association (NETA):
      a. NETA Acceptance Testing Specification - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
   5. National Electrical Manufacturers Association/Insulated Cable Engineers Association, Inc. (NEMA/ICEA):
      a. NEMA WC 70/ICEA S-95-658 - Power Cables Rated 2000 V or Less for the Distribution of Electrical Energy (ANSI)
   6. National Fire Protection Association (NFPA):
      a. NFPA 70 - National Electrical Code.
   7. Underwriters Laboratories Inc. (UL):
      a. UL 44 - Thermoset-Insulated Wires and Cables.
      b. UL 83 - Thermoplastic-Insulated Wires and Cables.
      c. UL 486A-486B - Wire Connectors.
      d. UL 493 - Thermoplastic-Insulated Underground Feeder and Branch-Circuit Cables.
      e. UL 2196 – Test for Fire Resistive Cables.

1.04 DEFINITIONS:

A. EPDM: Ethylene-propylene-diene terpolymer rubber.
B. NBR: Acrylonitrile-butadiene rubber.

1.05 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.

PART 2 - PRODUCTS

2.01 CONDUCTORS AND CABLES:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Senator Wire & Cable Company.; a subsidiary of Southwire Company.
   2. Southwire Company.
   3. United Copper Industries.
   4. Draka; a brand of Prysmian Group.

B. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.

C. Two hour fire resistive cables: Comply with UL 44 and UL 2196.

D. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Types THHN-THWN, XHHW.

E. Multiconductor Cable:
   1. Comply with NEMA WC 70/ICEA S-95-658 for metal-clad cable, Type HFC MC with ground wire.

2.02 CONNECTORS AND SPLICES:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   2. Cooper Bussmann; Eaton.
   3. Hubbell Power Systems, Inc.
   4. O-Z/Gedney; EGS Electrical Group LLC.
   5. 3M; Electrical Products Division.
   6. Tyco Electronics Corp.
   7. ILSCO.
   8. Ideal Industries, Inc.
   9. Frametone Connectors/Burndy Electrical.
   10. Thomas & Betts.
   11. Littelfuse.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.01 CONDUCTOR MATERIAL APPLICATIONS:

A. General: Provide wire and cable suitable for the location where installed.

B. Conductors: Minimum conductor size shall be #12 AWG.

C. Feeders:
   1. Copper. Solid for No. ***12*** AWG and smaller; stranded for No. ***10*** AWG and larger.

D. Branch Circuits: Copper. Solid for No. ***12*** AWG and smaller; stranded for No. ***10*** AWG and larger.

3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS:

A. Exposed Feeders: Type THHN-THWN or XHHW, single conductors in raceway.
B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-THWN or XHHW, single conductors in raceway.
C. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN or XHHW, single conductors in raceway.
    1. Health Care Facility Metal-clad cable, Type HCF- MC with ground wire may be used for lighting whips up to 6 feet long. Lighting whips must be dedicated and not daisy chained together.
    2. Metal-clad cable shall only be used for branch circuit wiring between luminaires downstream of a junction box located above at the ceiling of the room or area being served. Each luminaire on the circuit shall be located not more than 6 feet downstream of a junction box. Raceways extending to the branch circuit panelboard from the junction box at the ceiling shall comply with SECTION 26 05 33 - RACEWAYS, BOXES, SLEEVES, SEALS AND FITTINGS FOR ELECTRICAL SYSTEMS.
        a. MC Cable cannot be used for essential branch circuits.
D. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN or XHHW, single conductors in raceway.
    1. Health Care Facility Metal-clad cable, Type HCF- MC with ground wire may be used for lighting whips up to 6 feet long. Lighting whips must be dedicated and not daisy chained together.
    2. Metal-clad cable shall only be used for branch circuit wiring between luminaires downstream of a junction box located above the accessible ceiling of the room or area being served. Each luminaire on the circuit shall be located not more than 6 feet downstream of a junction box. Raceways extending to the branch circuit panelboard from the junction box above the ceiling shall comply with SECTION 26 05 33 - RACEWAYS, BOXES, SLEEVES, SEALS AND FITTINGS FOR ELECTRICAL SYSTEMS.
        a. MC Cable cannot be used for essential branch circuits.
E. Class 1 Control Circuits: Type THHN-THWN, in raceway.
F. Class 2 Control Circuits: Type THHN-THWN, in raceway.

3.03 INSTALLATION OF CONDUCTORS AND CABLES:

A. General: Install electrical cables, wires, and connectors in compliance with NEC.
B. Coordinate cable installation with other Work.
C. Do not pull wire and cable until raceway system is complete. Pull conductors simultaneously where more than one is being installed in same raceway.
D. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
E. 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.
F. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

G. Support cables according to SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS.
H. Zip ties are not allowed and shall not be utilized for the support of metal-clad (MC) cable except for securing to chain supporting suspended light fixtures located in electrical equipment rooms.
I. Identify and color-code conductors and cables according to SECTION 26 05 53 - ELECTRICAL IDENTIFICATION.

1. Insulation Color Coding for Phase Identification:
2. Color code 600V insulated, feeder and branch circuit conductors with factory-applied colored insulation as follows:

208Y/120V	Phase	480Y/277V
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray or White
Green	Ground	Green

J. For multi-wire branch circuits installed in a common raceway provide neutral insulation color noted above with tracer color corresponding to the phase the load is connected to.
K. Keep conductor splices to a minimum. All splices shall be made in junction boxes.
L. Provide adequate length of conductors within electrical enclosures and neatly train the conductors to terminal points. Circuits with conductors larger than No. 10 AWG shall be bundled together inside of enclosures. Make terminations so there are no bare conductors visible at the terminal.
M. Group circuits in conduit such that no conduit contains more than a total of three phase conductors, three neutral conductors, and one ground conductor (unless indicated or specified otherwise).
N. Provide a dedicated neutral conductor for each branch circuit. Sharing of neutrals is not acceptable.
O. Install wire and cable numbers on all field wiring that matches electrical schematics.
P. Wire phasing shall be A, B, C with Phase A connected to the left or top terminal, Phase B connected to the center terminal, and Phase C connected to the right or bottom terminal.
Q. All wire and cable shall be installed in raceways.

3.04 CONNECTIONS:

A. Provide UL-listed factory-fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types and classes for applications and for services indicated.
1. Conductor splices and taps for No. 10 AWG and smaller shall be twist-on spring solderless connectors or crimp pressure type connectors. Provide silicone filled twist-on watertight/raintight connectors for all circuits routed outdoors or indoors in wet locations.
2. Taps and bus bar terminations of conductors No. 8 AWG and larger shall be made with compression, crimp type connection devices.
3. Conductor splices No. 8 AWG and larger:

a. Finger safe power distribution blocks with short circuit and ampacity ratings appropriate for conductor being spliced.
b. Compression, crimp type two-way splice connector barrel for use with tool and die. Die code shall be embossed on connector after crimping.

4. All uninsulated joints shall be taped to provide an insulation value equal to that of the wire.

B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

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.

D. Wiring at Outlets: Install conductor at each outlet, with at least six (6) inches of slack.

3.05 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS:

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in SECTION 26 05 33 - RACEWAYS, BOXES, SLEEVES, SEALS AND FITTINGS FOR ELECTRICAL SYSTEMS.

3.06 FIRESTOPPING:

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to SECTION 07 84 13 - PENETRATION FIREPROOFING.

3.07 FIELD QUALITY CONTROL:

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Prior to energizing, test wires and cables for electrical continuity and for short circuits.
2. Prior to energizing, check all installed feeders and building service wires and cables with insulation megohm meter to determine insulation resistance levels to assure requirements are fulfilled. Record and submit all field test data. Megger 300V cables with 500Vdc megohm meter between each conductor and ground. Megger 600V cables with 1,000Vdc megger between each conductor and ground. Also, megger between adjacent conductors. Megger cables after installation (not on cable reel) with cables disconnected at both ends. Where existing feeders are extended to new electrical equipment, test new conductors prior to splicing to existing conductors. The values must be approximately as follows:

Conductor Size (AWG or MCM)	Resistance (Megohms-1,000 ft.)
14-8	200
6-2/0	100
3/0-500	50

3. Do not test wires or cables with an ac test set.
4. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
5. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each termination and splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so terminations and splices are accessible to portable scanner.
    a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    b. Record of Infrared Scanning: Prepare a certified report that identifies terminations and splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

C. Test Reports: Prepare a written report to record the following:
1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning units, conductors, or cables and retest as specified above.

END OF SECTION 26 05 19

SECTION 26 05 26 - GROUNDING

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 specifies electrical grounding and bonding as indicated on Drawings and schedules and as specified herein. Grounding and bonding work is defined to encompass systems, circuits, and equipment.

B. Type of electrical grounding and bonding work specified in this SECTION includes the following:
   1. Solidly grounded. Grounded through a ground connection in which no impedance has been intentionally inserted.

C. Applications of electrical grounding and bonding work in this SECTION include the following:
   1. Electrical power systems.
   2. Grounding electrodes.
   3. Separately derived systems.
   4. Raceways.
   5. Service equipment.
   6. Boxes and enclosures.
   7. Equipment.

D. Refer to other DIVISION 26 SECTIONS for wires/cables, electrical raceways, boxes and fittings, and wiring devices which are required in conjunction with electrical grounding and bonding work; not work of this SECTION.

1.03 REFERENCES:

A. Applicable Standards:
   1. ASTM International:
      a. ASTM B 3-13 – Specification for Soft or Annealed Copper Wire.
      b. ASTM B 8-11 – Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft.
      c. ASTM B 33-10 – Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes.
   2. Institute of Electrical and Electronic Engineers (IEEE): Comply with applicable requirements and recommended installation practices of the following IEEE Standards pertaining to grounding and bonding of systems, circuits, and equipment:
      a. 81 - Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.
      b. 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
   3. International Electrical Testing Association (NETA):
      a. NETA Acceptance Testing Specification - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
   4. National Electrical Manufacturers Association/Insulated Cable Engineers Association, Inc. (NEMA/ICEA):

a. NEMA WC 70/ICEA S-95-658 - Power Cables Rated 2000 V or Less for the Distribution of Electrical Energy (ANSI)

5. National Fire Protection Association (NFPA):
   a. 70 - National Electrical Code (NEC): Comply with applicable local electrical code requirements of the authority having jurisdiction, and NEC as applicable to electrical grounding and bonding, pertaining to systems, circuits, and equipment.
6. Underwriters Laboratories (UL): Comply with applicable requirements of the following standards. Provide grounding and bonding products which are UL-listed and labeled for their intended usage.
   a. UL 44 - Thermoset-Insulated Wires and Cables.
   b. UL 83 - Thermoplastic-Insulated Wires and Cables.
   c. 467 - Electrical Grounding and Bonding Equipment.
   d. 486A-486B - Wire Connectors.
   e. 869A - Electrical Service Equipment.

1.04 SUBMITTALS:

A. Refer to DIVISION 01 for administrative and procedural requirements for Submittals.
B. Includes, but not limited to, the following:
   1. Product Data: Submit manufacturer's data on grounding and bonding products and associated accessories.
   2. All field test reports.

1.05 QUALITY ASSURANCE:

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Subject to compliance with requirements, provide grounding and bonding products of one of the following (for each type of product):
   1. Grounding Products:
      a. Anderson; Hubbell Inc.
      b. Burndy Corporation.
      c. Cadweld Div; Erico Products Inc.
      d. Crouse-Hinds Div; Cooper Industries.
      e. Ideal Industries, Inc.
      f. ILSCO
      g. O. Z. Gedney Div; Emerson Electric Co.
      h. Thomas and Betts Corp.

2.02 GROUNDING AND BONDING:

A. Materials and Components:
   1. General: Except as otherwise indicated, provide electrical grounding and bonding systems indicated; with assembly of materials, including, but not limited to, cables/wires, connectors, solderless lug terminals, grounding electrodes, bonding jumper braid, surge arresters, and additional accessories needed for a complete installation. Where more than

one type component product meets indicated requirements, selection is Contractor's code-compliance option. Where materials or components are not indicated, provide products which comply with NEC, UL, and IEEE requirements and with established industry standards for those applications.

2. Conductors: Unless otherwise indicated, provide insulated electrical grounding conductors for equipment grounding conductor connections that match power supply wiring materials and as a minimum are sized according to the NEC. Provide insulated, stranded, copper cable for grounding electrode conductors.
   a. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
   b. Bare Copper Conductors:
      (1) Solid Conductors: ASTM B3-13.
      (2) Stranded Conductors: ASTM B8-11.
      (3) Tinned Conductors: ASTM B33-10.
      (4) Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
      (5) Bonding Conductor: No. 4, stranded conductor.
      (6) Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
      (7) Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
3. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross SECTION, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600V. Lexan or PVC, impulse tested at 5,000V.
4. Bonding Plates, Connectors, Terminals, and Clamps: 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. Provide electrical bonding plates, connectors, terminals, lugs, and clamps as recommended by bonding plate, connector, terminal, and clamp manufacturers for indicated applications.
   a. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.
      (1) Pipe Connectors: Clamp type, sized for pipe.
   b. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
   c. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression crimp -type wire terminals and long-barrel, two-bolt connection to ground bus bar.
5. Electrical Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type service required or indicated.
6. Field Welding: Provide exothermic welded or irreversible compression joint connections crimped with minimum 14-ton hydraulic tool where grounding conductors connect to underground grounding conductors and electrodes and where indicated on Drawings.

PART 3 - EXECUTION

3.01 APPLICATIONS:

A. Install electrical grounding and bonding systems as indicated, in accordance with manufacturer's instructions and applicable portions of NEC, NECA's "Standard of Installation,"

and in accordance with recognized industry practices to ensure that products comply with requirements.

B. Conductors: Install solid conductor for No. 10 AWG and smaller, and stranded conductors for No. 8 AWG and larger unless otherwise indicated.

C. Grounding in patient care spaces to be compliant with NEC 517.

D. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
   1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
   2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down to specified height above floor; connect to horizontal bus.

E. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   2. Connection to underground Connections: Welded or irreversible crimp compression connectors.
   3. Connections to Structural Steel: Welded connectors or compression-type ground stud connector.
   4. Clean metal contact surfaces of clamp-on connectors to ensure electrical conductivity and circuit integrity.

3.02 EQUIPMENT GROUNDING:

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Terminate feeder and branch circuit insulated equipment grounding conductors with grounding lug on substation, switchgear, switchboard, motor control center, or panelboard ground bus. When conduit enters from below and is not connected to the enclosure, ground equipment grounding conductor on conduit grounding bushing and then bond to ground bus (or grounded enclosure if there is no ground bus).

C. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
   1. Feeders and branch circuits.
   2. Lighting circuits.
   3. Receptacle circuits.
   4. Single-phase motor and appliance branch circuits.
   5. Three-phase motor and appliance branch circuits.

3.03 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. 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.

C. Ground each separately derived system neutral to:
   1. Effectively ground to concrete structure rebar.
   2. Main building ground system.

D. Bond the system neutral to service entrance equipment enclosures.
E. Ground all exposed noncurrent carrying metal parts of electrical equipment, metal raceway systems, grounding conductors in raceways and cables, receptacle ground conductors, and metallic plumbing systems.
F. 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 tightening torque values specified in UL 486A-486B to assure permanent and effective grounding.
G. Apply corrosion-resistant finish to field connections, buried metallic grounding and bonding products, and places where factory applied protective coatings have been destroyed, which are subjected to corrosive action.

3.04 LABELING:
A. Comply with requirements in SECTION 26 05 53 - ELECTRICAL IDENTIFICATION for instruction signs. The label or its text shall be green.
B. Install labels at ground bus bars and at the grounding electrode conductor where exposed.
1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.05 FIELD QUALITY CONTROL:
A. Perform tests and inspections.
B. Tests and Inspections:
1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and exposed ground bus bar locations.
a. Perform tests by fall-of-potential method according to IEEE 81.
C. Grounding system will be considered defective if it does not pass tests and inspections.
D. Prepare test and inspection reports.
1. Report measured ground resistances that exceed the following values:
2. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 5 ohms.
3. Power and Lighting Equipment or System with Capacity of 500 to 1,000 kVA: 5 ohms.
4. Power and Lighting Equipment or System with Capacity More Than 1,000 kVA: 5 ohms.
5. Pad-Mounted Equipment: 5 ohms.
E. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 05 26

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SECTION 26 05 29 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification SECTIONS, apply to this SECTION.

1.02 SUMMARY:

A. This SECTION specifies hangers, supports, and anchors, for electrical equipment and systems as well as construction requirements for concrete bases specified in other DIVISION 26 SECTIONS.

B. Types of hangers, supports, anchors, sleeves, and seals specified in this SECTION include the following:
   1. Clevis hangers.
   2. Riser clamps.
   3. Steel rod coupling.
   4. C-clamps.
   5. I-beam clamps.
   6. One-hole conduit straps.
   7. Two-hole conduit straps.
   8. Hexagonal nuts.
   9. Round threaded steel rods.
   10. Conduit clamps.
   11. U-bolts.
   12. Toggle bolts.
   13. Conduit cable supports.
   14. U-channel strut system.
   15. Fire and smoke stop compounds.

1.03 RELATED REQUIREMENTS:

A. Supports, anchors, sleeves, and seals furnished as part of factory-fabricated equipment, are specified as part of that equipment assembly in other DIVISION 26 SECTIONS.

B. SECTION 26 05 26 - GROUNDING.

C. SECTION 26 05 48 – SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS.

1.04 REFERENCE STANDARDS:

A. Applicable Standards: Comply with the following standards.
   1. ASTM International:
      a. A 36/A 36M-04: Carbon Structural Steel.
      b. A 325-04: Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
      c. A 780-01: Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
      d. E 84-13a: Test Method for Surface Burning Characteristics of Building Materials
      e. D 635-10: Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
      f. E 814 - Standard Test Method for Fire Tests of Penetration Firestop Systems.
   2. Manufacturers Standardization Society of The Valve Fitting Industry Inc.

a. MSS SP-58: Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

3. National Electrical Contractors Association
   a. 1: Standard Practices for Good Workmanship in Electrical Construction
   b. 101: Standard for Installing Steel Conduits (Rigid, IMC, EMT)
4. National Fire Protection Association (NFPA):
   a. 70 - National Electrical Code (NEC).
5. National Electrical Contractors Association (NECA):
   a. Standard of Installation - Pertaining to anchors, fasteners, hangers, supports, and equipment mounting.
6. Underwriters Laboratories (UL):
   a. Provide electrical devices, components, and fire stops which are UL-listed and labeled.

1.05 PERFORMANCE/DESIGN CRITERIA:

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Rated 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 five times the applied force.

1.06 SUBMITTALS:

A. Refer to DIVISION 01 for administrative and procedural requirements for submittals.

B. Includes, but not limited to, the following:
   1. Product Data: Submit manufacture's data on supporting devices including catalog cuts, specifications, and installation instructions, for each type of support, anchor, sleeve, and seal.

1.07 QUALITY ASSURANCE:

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

1.08 COORDINATION:

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete specifications.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Anchor Manufacturers: Subject to compliance with requirements, provide anchors of one of the following manufacturers.
   1. Cooper B-Line, Inc.; a division of Cooper Industries.
   2. Empire Industries, Inc.
   3. Hilti, Inc.
   4. Unistrut; Atkore International.

B. Channel System Manufacturers: Subject to compliance with requirements, provide channel system of one of the following manufacturers.
   1. Allied Tube & Conduit Corp.
   2. Eaton/Cooper; B-Line Systems, Industries.
   3. Erico International Corp.
   4. Kindorf; Thomas & Betts Corp.
   5. Power-Strut; Power Engineering Co.
   6. Unistrut; Atkore International.

C. Fire and Smoke Stop Compounds: Subject to compliance with requirements, provide channel system of one of the following manufacturers.
   1. 3M Company.
   2. Hilti, Inc.

2.02 MATERIALS:

A. General: Provide supporting devices which comply with manufacturer's standard materials, design, and construction in accordance with published product information, as required for complete installation, and as herein specified. All supports shall be designed for the support of the maximum number of conduits and their maximum conductor weights for maximum conduit loading. Where more than one type of supporting device meets indicated requirements, selection is Contractor's option. Do not use perforated metal straps for supports.

B. Supports: Supporting devices of types, sizes, and materials indicated, and having the following construction features.
   1. Clevis Conduit Hangers: For supporting conduit; galvanized steel; with 3/8-, 1/2-, 5/8- or 3/4-inch rod, size of clevis and rod as required.
   2. Riser Clamps: For supporting conduit, galvanized steel, with two bolts and nuts.
   3. Steel Rod Couplings: Provide 3/8-, 1/2-, 5/8- or 3/4-inch straight rod couplings, size as required.
   4. C-Beam Clamps: Malleable iron, 3/8-, 1/2-, 5/8-, or 3/4-inch rod, size as required.
   5. I-Beam Clamps: Galvanized steel, with 3/8, 1/2-, 5/8-, or 3/4-inch rod, size as required; 3/8-inch horizontal "J" hook safety rod that bolts across the flange, flange width as required.
   6. One-Hole Conduit Straps: For supporting conduit; stamped plated steel, size as required.
   7. Two-Hole Conduit Straps: For supporting conduit, stamped plated steel, size as required.
   8. Hexagonal Nuts, Flat Washers and Lock Washers: For 3/8-, 1/2-, 5/8-, or 3/4-inch rod, size as required; galvanized steel.
   9. Round Threaded Steel Rod: Galvanized steel, 3/8-, 1/2-, 5/8-, or 3/4-inch diameter, size as required. Minimum size is 3/8-inch diameter.
   10. Conduit Clamps: For supporting conduit; galvanized stamped steel, size as required.
   11. U-Bolts: For supporting conduit; galvanized, size as required.

C. Anchors: Anchors of types, sizes and materials as required, with the following construction features.
   1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
   2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
   3. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A325.Toggle Bolts: Springhead, 3/16 by 4 inch or larger size as required.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
E. Structural Steel for Fabricated Supports and Restraints: ASTM A36 & A36M, steel plates, shapes, and bars; black and galvanized.
F. Steel U-Channel Strut Systems: Unless indicated otherwise, U-channel strut system for supporting electrical equipment, 12-gauge steel hot-dip galvanized after fabrication for wet and outdoor locations, 12-gauge standard green paint finish for dry and indoor locations, of types and sizes indicated; construct with 9/16-inch diameter holes, 8 inch o.c. on top surface, and with the fittings as required which mate and match with U-channel.
    1. Comply with MFMA-4, factory-fabricated components for field assembly.
    2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
    3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
    4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
    5. Channel Dimensions: Selected for applicable load criteria.
G. Fire and Smoke Stop Compounds: Comply with Owner's firestopping program guidelines and procedures.

PART 3 - EXECUTION

3.01 ERECTION, INSTALLATION, APPLICATION:

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this SECTION are stricter.
B. Install hangers and anchors as specified, required, indicated, in accordance with manufacturer's written instructions and with recognized industry practices to insure supporting devices comply with requirements
C. Install hangers, supports, clamps, and attachments to support conduit properly from building structure. Arrange for grouping of parallel runs of horizontal conduits to be supported together on trapeze type hangers where possible. Install supports with spacings indicated and as required by the NEC or as indicated when less than NEC required spacing.
D. Design trapeze type supports, including fasteners to the structure to carry the following loads:
    1. The greater of the following:
        a. The total calculated load multiplied by a factor of 4.
        b. The total calculated load +200 pounds.
E. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
    1. To Wood: Fasten with lag screws or through bolts.
    2. To New Concrete: Bolt to concrete inserts.
    3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
    4. To Existing Concrete: Expansion anchor fasteners.
    5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
    6. To Light Steel: Sheet metal screws.

7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

F. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

G. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

H. Repair damage to painted finishes with paint recommended by manufacturer.

I. Install fire and smoke stop compounds at all penetrations of fire rated walls, floors, ceilings and roofs. Install fire and smoke stop compounds in accordance with manufacturer's instructions to provide a fire seal rating equal to or greater than that of the surface penetrated.

J. Zip ties are not allowed and shall not be utilized for the support of metal-clad (MC) cable except where attached to chain supports for pendant mounted light fixture.

3.02 CONCRETE BASES:

A. Provide concrete bases for all floor mounted electrical equipment of dimensions not less than 4 inches larger in both directions than supported unit, minimum of 4 inches high, with 3/4" chamfered edges, and so anchors will be a minimum of 10 bolt diameters from edge of the base. Reinforce concrete base with #4 bars at 18" on center with 1-1/2" clear from top of base.

B. All cement shall be Type I cement and conform to ASTM C150 and have a minimum 28 day compressive strength of 4000-psi with the following requirements:
   1. Maximum slump shall be 4" +/- 1"
   2. Maximum water cement ratio shall be 0.45

C. Aggregates for normal weight concrete shall conform to ASTM C33 "Specification for Concrete Aggregates". The nominal maximum size of aggregate shall not be more than 3/4".

D. Horizontal concrete surfaces shall be wood floated to depress coarse aggregate and steel troweled to a smooth finish.

E. Use Hilti Hit-RE 500 adhesive or approved equal for dowelled connections to existing concrete.

F. Install dowel rods to connect concrete bases to concrete floor. Provide #3 bars for dowels and embed into existing slab 3" with standard ACI hook centered in concrete base. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.

G. Reinforcing shall be ASTM A615 Grade 60.

H. Contractor shall detail and place all reinforcement in accordance with ACI SP-66 Details and Detailing for Concrete Reinforcement.

I. Anchor equipment to concrete base.
   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.
   4. Anchor switchgear assemblies to channel-iron floor sills embedded in concrete bases and attach by bolting. Install sills level and grout flush with floor or base. Select sills to suit switchgear assemblies.

3.03 PAINTING:

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION 26 05 29

SECTION 26 05 33 – RACEWAYS, BOXES, SLEEVES, SEALS AND FITTINGS 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. This SECTION specifies the following:
   1. Conduit.
   2. Wireway.
   3. Outlet and device boxes.
   4. Weatherproof boxes.
   5. Junction boxes.
   6. Pull boxes.
   7. Fittings.
   8. Bushings and ground bushings.
   9. Locknuts.
   10. Knockout closures.
   11. Supports and accessories.
   12. Sleeve-seal systems.
   13. Sleeve-seal fittings.
   14. Grout.
   15. Silicone sealants.

1.03 RELATED REQUIREMENTS:

A. SECTION 07 84 13 - PENETRATION FIREPROOFING for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.
B. SECTION 26 05 26 - GROUNDING.
C. SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS.

1.04 DEFINITIONS:

A. EMT: Electrical metallic tubing.
B. FMC: Flexible metal conduit.
C. GRC: Galvanized rigid steel conduit.
D. LFMC: Liquid-tight flexible metal conduit.
E. RNC: Rigid nonmetallic conduit.

1.05 REFERENCE STANDARDS:

A. Applicable Standards: Comply with applicable requirements of the following standards.
   1. National Electrical Manufacturers Association (NEMA):
      a. FB1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable (ANSI).
      b. FB2 - Selection and Installation Guidelines - Fittings for Use with Non-Flexible Metallic Conduit or Tubing (Rigid Metal Conduit, Intermediate Metal Conduit and Electrical Metallic Tubing).
      c. FB2.20 - Selection and Installation Guidelines for Fittings for Use with Flexible

Electrical Conduit and Cable.
d. RV3 - Application and Installation Guidelines for Flexible and Liquidtight Flexible Metal and Nonmetallic Conduits.
e. OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports.
f. 250 - Enclosures for Electrical Equipment (1,000V Maximum).

2. National Fire Protection Association (NFPA):
   a. 70 - National Electrical Code, (NEC). Comply with applicable requirements of NEC pertaining to construction and installation of raceway systems.
3. Underwriters Laboratories (UL):
   a. Provide all devices and equipment which are UL listed and labeled.
   b. 1 – Standards for Flexible Metal Conduit.
   c. 5 – Standard for Surface Metal Raceways and Fittings.
   d. 5B – Standard for Strut-Type Channel Raceways and Fittings.
   e. 6 - Electrical Rigid Metal Conduit - Steel.
   f. 50 – Enclosures for Electrical Equipment, Non-Environmental Considerations.
   g. 50E - Enclosures for Electrical Equipment, Environmental Considerations.
   h. 360 – Liquid-Tight Flexible Metal Conduit.
   i. 467 – Grounding and Bonding Equipment.
   j. 514A – Metallic Outlet Boxes
   k. 514B – Conduit, Tubing, and Cable Fittings.
   l. 514C – Standard for Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.
   m. 797 - Electrical Metallic Tubing - Steel.
   n. 870 – Standard for Wireways, Auxiliary Gutters, and Associated Fittings.
   o. 1773 – Termination Boxes.
4. American National Standards Institute (ANSI):
   a. C80.1 – Electrical Rigid Steel Conduit (ERSC).
   b. C80.3 – Steel Electrical Metallic Tubing (EMT).
5. National Electrical Contractor's Association (NECA):
   a. 1 - Standard for Good Workmanship in Electrical Construction.
   b. 101 – Standard for Installing Steel Conduits (Rigid, IMC, EMT)

1.06 SUBMITTALS:

A. Refer to DIVISION 01 and SECTION 26 05 10 - Basic Electrical Requirements for administrative and procedural requirements for submittals.
B. Submittals shall include, but not be limited to, the following:
   1. Product Data:
      a. Submit manufacturer's technical product data, including specifications and installation instructions, for each type of product required. Include data substantiating that materials comply with requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Subject to compliance with requirements, provide each type of raceway from one of the following:
   1. Rigid Steel Conduit:
      a. Allied Tube & Conduit; Atkore International.

b. Republic Conduit, Inc.
c. Wheatland Tube Co.
d. Western Tube & Conduit Corporation.

2. EMT:
   a. Allied Tube and Conduit; Atkore International.
   b. Republic Conduit, Inc.
   c. Wheatland Tube Co.; JMC Steel Group.
   d. Western Tube & Conduit Corporation.
3. Flexible Metal Conduit:
   a. AFC Cable Systems; Atkore International.
   b. Anaconda Sealtite; Division of ANAMET Electrical, Inc.
   c. Electri-Flex Co.
   d. Southwire Company.
4. Liquid-Tight, Flexible Metal Conduit:
   a. AFC Cable Systems; Atkore International.
   b. Anaconda Sealtite; Division of ANAMET Electrical, Inc.
   c. Electri-Flex Co.
   d. Southwire Company.
5. Rigid Metal Conduit Fittings:
   a. Appleton; EGS Electrical Group.
   b. Raco; Hubbell Company.
   c. Thomas & Betts Corp.
6. Flexible Metal Conduit Fittings:
   a. Appleton; EGS Electrical Group.
   b. Electri-Flex Co.
   c. O-Z/Gedney; EGS Electrical Group.
7. Liquid-tight Flexible Metal Conduit Fittings:
   a. Appleton; EGS Electrical Group.
   b. Electri-Flex Co.
   c. O-Z/Gedney; EGS Electrical Group.
8. EMT Fittings:
   a. Appleton; EGS Electrical Group.
   b. Raco; Hubbell Company.
   c. Thomas & Betts Corp.
9. Wireway:
   a. Hoffman; Pentair Equipment Protection.
   b. Schneider Electric.
10. Conduit Bodies:
    a. Appleton; EGS Electrical Group.
    b. Arrow-Hart Div; Cooper Industries.
    c. Killark; Hubbell Inc.
    d. O-Z/Gedney; EGS Electrical Group.
11. Interior Boxes:
    a. Appleton; EGS Electrical Group.
    b. Bell; Hubbell, Inc.
    c. O-Z/Gedney; EGS Electrical Group.
    d. Pass and Seymour; Legrand.

e. Raco; Hubbell, Inc.
f. Steel City; Thomas & Betts Corp.

12. Weatherproof Boxes:
    a. Appleton; EGS Electrical Group.
    b. Arrow Hart; Eaton.
    c. Hubbell, Inc.
    d. O-Z/Gedney; EGS Electrical Group.
    e. Pass and Seymour; Legrand.
13. Junction and Pull Boxes:
    a. Appleton; EGS Electrical Group.
    b. Arrow Hart; Eaton.
    c. Bell Electric, Square D Company.
    d. Hoffman Engineering Company.
    e. O-Z/Gedney; EGS Electrical Group.
14. Bushings, Grounding Bushings and Locknuts:
    a. Arrow Hart; Eaton.
    b. Appleton; EGS Electrical Group.
    c. O-Z/Gedney; EGS Electrical Group.
    d. Raco; Hubbell, Inc.
    e. Steel City; Thomas & Betts Corp.
15. Electrical Enclosures:
    a. Hoffman; Pentair Equipment Protection.
    b. Wiegmann; Hubbell, Inc.
16. Sleeve-Seal Systems:
    a. Advance Products & Systems, Inc.
    b. CALPICO, Inc.
    c. Metraflex Company (The).
    d. Pipeline Seal and Insulator, Inc.
    e. Proco Products, Inc.
17. Sleeve-Seal Fittings:
    a. Link-Seal.
    b. Presealed Systems.

2.02 METAL CONDUIT AND TUBING:

A. General: Provide metal conduit, tubing, and fittings of types, grades, sizes, and weights (wall thicknesses) for each service indicated. Where types and grades are not specified or indicated, provide proper selection to fulfill specified requirements, and comply with applicable portions of NEC for raceways. Minimum size shall be 3/4 inch for branch circuits and 1 inch for feeders, unless indicated or specified otherwise.
    1. Exception: Where connected to switch legs, lighting whips (supplying a single fixture circuit), and control wiring, 1/2 inch conduit is allowed.
B. Rigid Steel Conduit: Rigid steel, hot dipped galvanized zinc coated, threaded type conforming to UL6A.
    1. Zinc coating fused to inside and outside walls.
C. Electrical Metallic Tubing (EMT): UL797.
    1. Conduits in EMT to match MU campus standard color coded conduit.
        a. Red = Life safety branch

b. Orange = Critical branch
c. Yellow = Equipment Branch
d. Red conduit with red j-box = Fire Alarm

D. Flexible Metal Conduit: UL1. Formed from continuous length of spirally-wound, interlocked zinc-coated strip steel. Minimum size shall be 3/4 inch unless indicated or specified otherwise.

E. Liquid-Tight, Flexible Metal Conduit: Liquid-tight flexible metal conduit; construct of single strip, flexible, continuous, interlocked, and double-wrapped steel; galvanized inside and outside; coat with oil-resistant, liquid-tight thermoplastic jacket.

F. Rigid Metal Conduit Fittings: Threaded cast-malleable iron, galvanized or cadmium plated, conforming to UL 514B.
1. Provide steel fittings for steel conduit.

G. Flexible Metal Conduit Fittings: Threadless hinged clamp type. Provide conduit fittings for use with flexible steel conduit. Fittings shall be approved for grounding per NEC 348.60.
1. Straight Terminal Connectors: One-piece body, female end with clamp and deep slotted machine screw for securing conduit, and male threaded end provide with locknut.
2. 45 degree or 90 degree Terminal Angle Connectors: Two piece body construction with removable upper section, female end with clamp and deep slotted machine screw for securing conduit, and male threaded end provided with locknut.

H. Liquid-Tight Flexible Metal Conduit Fittings: Provide cadmium plated, malleable-iron fittings with compression type steel ferrule and neoprene gasket sealing rings, with insulated or noninsulated throat. Fittings shall be approved for grounding in conduit sizes 1-1/4 inch and smaller per NEC 350.60.

I. Conduit Bodies: Galvanized cast-metal conduit bodies of types, shapes, and sizes as required to fulfill job requirements and NEC requirements. Construct conduit bodies with threaded conduit entrance ends, removable covers, either cast or of galvanized steel, and corrosion-resistant screws.

J. Conduit and Tubing Accessories: Provide conduit and tubing accessories of types, sizes, and materials, complying with manufacturer's published product information which mate and match conduit and tubing.

K. Conduit Bushings: Provide insulated throat for all bushings. Grounding bushings shall have an integral copper set-screw type cable grounding lug.

2.03 WIREWAYS:

A. General: Provide electrical wireways of types, grades, sizes, and number of channels for each type of service only where indicated on Drawings. Provide complete assembly of raceway including, but not limited to, couplings, offsets, elbows, expansion joints, adapters, holddown straps, end caps, and other components and accessories as required for complete system.

B. Lay-in Wireways: NEMA 1. Provide 2.5 by 2.5 inch, 4 by 4 inch, 6 by 6 inch, 8 by 8 inch and 12 by 12 inch sizes as indicated or required. Construct lay-in wireways with hinged covers, in accordance with UL870 and with components UL listed, including lengths, connectors, and fittings. Wireways shall allow fastening hinged cover closed without use of parts other than standard lengths, fittings, and connectors. The 2 1/2-inch, 4-inch and 6 inch wireways shall be constructed with 16 gauge steel. The 8-inch and 12-inch wireways shall be constructed with 14-gauge steel. Wireway shall be painted with epoxy paint. Units shall be capable of sealing cover in closed position with screws. Provide NEMA 1 wireways in the 2 1/2 inch, 4 inch and 6 inch sizes with knockouts.

1. Connectors: Provide wireway connectors suitable for lay in conductors, with connector covers permanently attached such that removal is not necessary to utilize the lay in feature.
2. Finish: Protect sheet metal parts with rust inhibiting coating and baked enamel finish. Plate finish hardware to prevent corrosion. Protect screws installed toward inside of wireway with spring nuts to prevent wire insulation damage.

2.04 FABRICATED MATERIALS:

A. Outlet Boxes: Galvanized, coated, flat rolled, sheet-steel outlet wiring boxes, of shapes, cubic inch capacities, and sizes, including box depths as required, indicated, and specified, suitable for installation at respective locations. Construct outlet boxes with mounting holes and with conduit knockout openings in bottom and sides. Provide boxes with threaded screw holes for grounding screws, fastening devices, box covers, and for equipment grounding. Minimum box size shall be 4-inch by 4-inch by 2.25 inches, provide larger box if required, specified or indicated otherwise.

B. Device Boxes: Galvanized, coated, flat rolled, sheet-steel gangable device boxes, of shapes, cubic inch capacities, and sizes, including box depths as required, indicated, and specified, suitable for installation at respective locations. Construct device boxes for flush mounting with mounting holes, with conduit knockout openings in bottom and sides, and with threaded screw holes for fastening devices and box covers. Provide corrosion-resistant screws for equipment grounding. Minimum box size shall be 4-inch by 4-inch by 2.25 inches, provide larger box if required, specified or indicated otherwise.
   1. Device Box Accessories: Provide as required for each installation, including mounting brackets, device box extensions, switch box supports, plaster ears, and plaster board expandable grip fasteners (use only in existing walls) which are compatible with device boxes being utilized to fulfill installation requirements for individual wiring situations. Choice of accessories is Contractor's code-compliance option.

C. Weatherproof Boxes: Corrosion-resistant, cast-metal, weatherproof, outlet wiring boxes, of types, shapes, and sizes, including depth of boxes as required with threaded conduit hubs for fastening electrical conduit. Provide cast-metal face plates with spring-hinged, watertight caps suitably configured for each application, including face plate gaskets and corrosion-resistant fasteners.

D. Junction and Pull Boxes: Galvanized, code-gage sheet steel junction and pull boxes, with screw-on covers; of types, shapes, and sizes, to suit each respective location and installation; with welded seams and equipped with manufacturer's standard corrosion resistant steel nuts, bolts, screws and washers.

E. Bushings: Provide threaded, nylon insulated metallic bushings. Provide steel bushings for conduit sizes 1.5 inches and smaller. Provide malleable iron bushings for conduit sizes 2 inches and larger.

F. Grounding Bushings: Provided where indicated, specified and required by NEC. Provide threaded, insulated, malleable iron bushing with lay-in screw clamp lug.

G. Locknuts: Provide steel locknuts for conduit sizes 2 inches and smaller. Provide malleable iron for conduit sizes 2.5 inches and larger.

H. Sealing Hub: Provide watertight, threaded, insulated sealing hub connectors for all outdoor and indoor wet locations where conduit enters into enclosures. Sealing hub threaded lengths shall be adequate to allow installation of bushing.

I. Knockout Closures: Provide steel press-in knockout seals for all unused punched out knockouts 2 inches and smaller. Provide steel two-piece bolt on knockout seals for all unused punched out knockouts 2.5 inches and larger.

J. Fittings: Provide all threaded nipples, insulated short elbows, offset nipples, offset connectors, enlargers and reducers as required. Provide EMT compression type connectors with insulated throat. Provide EMT compression type insulated short elbows as required. Provide EMT set-screw type offset connectors as required.

K. Hinged-Cover Enclosures:
   1. Comply with UL 50 and NEMA 250, TYPE 1, or TYPE 3R with continuous-hinge cover with flush latch unless otherwise indicated.
      a. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
      b. Nonmetallic Enclosures: Fiberglass.
      c. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

L. Cabinets:
   1. NEMA 250, Type 1, or Type 3R galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
   2. Hinged door in front cover with flush latch and concealed hinge.
   3. Key latch to match panelboards.
   4. Metal barriers to separate wiring of different systems and voltage.
   5. Accessory feet where required for freestanding equipment.
   6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.05 SLEEVES:

A. Wall Sleeves:
   1. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Sleeves for Rectangular Openings:
   1. Material: Galvanized sheet steel.
   2. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
      b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.06 SLEEVE-SEAL SYSTEMS:

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
   1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Carbon steel.

3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.07 SLEEVE-SEAL FITTINGS:

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

2.08 GROUT:

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
C. Design Mix: 5000-psi, 28-day compressive strength.
D. Packaging: Premixed and factory packaged.

2.09 SILICONE SEALANTS:

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
   1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.01 INSTALLATION OF RACEWAYS:

A. General:
   1. Install raceways as indicated in accordance with manufacturer's written installation instructions and in compliance with NEC. Install raceways plumb and level, and maintain NEC recommended clearances. Provide raceway supports in accordance with the NEC and SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS.
B. Coordinate with other work including wires/cables, boxes, and panel work as necessary to interface installation of electrical raceways and components with other work.

3.02 INSTALLATION OF CONDUITS:

A. General: Install concealed conduits in new construction work - in walls or above suspended ceilings. Run conduits concealed in existing work where practicable. Where conduits cannot be concealed in finished areas, use surface metal raceways only where indicated on drawings. Utilize factory provided knockouts in boxes, panels and enclosures for connecting conduit. Provide holes for conduit in boxes, panels and enclosures only where factory provided knockouts cannot be utilized and the UL listing of the box, panel or enclosure will not be voided. For fire alarm panels, utilize factory provided knockouts only.
   1. All conduit installed above grade including exposed and concealed above removable suspended ceilings that contains emergency power and emergency lighting conductors shall be identified in accordance with SECTION 26 05 53 – ELECTRICAL IDENTIFICATION.

2. Mechanically fasten together metal conduits, enclosures, and raceways to form continuous electrical conductor. Connect to electrical boxes, fittings, and cabinets to provide electrical continuity and firm mechanical assembly.
3. Avoid use of dissimilar metals throughout system to eliminate possibility of galvanic corrosion. Where dissimilar metals are in contact, coat surfaces with corrosion inhibiting compound before assembling.
4. Install miscellaneous fittings such as reducers, close nipples, 3 piece unions, split couplings, and plugs that have been specifically designed and manufactured for their particular application. Install telescoping type linear expansion fittings in raceways every 200 foot linear run and wherever structural expansion joints are crossed.
5. Use roughing-in dimensions of electrically powered units furnished by unit manufacturer. Set conduit and boxes for connection to units only after receiving dimensions and after checking location with other trades.
6. Test conduits witnessed by the Owner's representative required to be installed but left empty with pull string. Provide 200-pound tensile strength nylon conduit fish line throughout the entire length of all empty conduits. Leave 12 inches of slack at each end.
7. Do not install conduit in front of covers of new and existing electrical equipment, pull boxes, and junction boxes.
8. Provide all openings in floors, walls, ceilings and roofs for passage of conduit. Fire ratings of walls, floors, ceiling and roofs shall be maintained when passing through them by providing fire seals.
9. Where different conduits contain circuits of different noise levels, the horizontal and vertical spacing in inches between the outside surfaces of the conduits or conduit to cable tray shall not be less than indicated below unless specified otherwise, indicated otherwise, or required otherwise by the equipment manufacturer:
    a. Noise Level 1 Circuits: Analog circuits less than 50V, digital circuits less than 12V or telephone circuits.
    b. Noise Level 2 Circuits: Analog circuits greater than 50V or digital circuits greater than 12V.
    c. Noise Level 3 Circuits: 120Vac or dc circuits operating at less than 20 amperes.
    d. Noise Level 4 Circuits: Ac or dc circuits less than 800V operating with currents less than 800 amperes.
    e. Noise Level 5 Circuits: Circuits over 800Vac or dc and/or over 800 amperes.

MINIMUM HORIZONTAL AND VERTICAL SPACING BETWEEN DIFFERENT CONDUIT OUTSIDE SURFACES (OR CONDUIT TO CABLE TRAY) IN INCHES					
NOISE LEVEL	1	2	3	4	5
1	*	1	3	12	12
2	1	*	3	9	12
3	3	3	*	*	6
4	12	9	*	*	*
5	12	12	6	*	*
* = MINIMUM SEPARATION REQUIRED FOR INSTALLATION OF LOCKNUTS AS IF ADJACENT CONDUIT WERE TERMINATING IN AN ENCLOSURE.					

10. Provide a weatherproof duct seal compound between the conductors and the inner walls of all conduit that are routed to NEMA 3, 3R, 3S, 4 and 4X enclosures to prohibit moisture and/or humid air from entering the raceway and condensing.
11. Repair damage to galvanized finishes with a zinc-rich paint recommended by the manufacturer.

3.03 RACEWAY APPLICATION:

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
   1. Exposed Conduit: RMC.
   2. Concealed Conduit, Aboveground: RMC.
   3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
   4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:
   1. Exposed, Not Subject to Physical Damage: EMT.
   2. Exposed and Subject to Physical Damage:
      a. EMT where located 7 feet above finished floor or higher.
      b. EMT for conduit sizes 2” or larger in diameter.
      c. Locations include:
         (1) Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
         (2) Mechanical rooms.
         (3) Spec revised. Storage rooms and janitor’s closets.
   3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
   4. Concealed in Existing to Remain Interior Walls and Partitions: FMC. Shall only be utilized from junction box located above the ceiling to the back box in the existing to remain wall or partition. Lengths not to exceed 72 inches.
   5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
   6. Damp or Wet Locations: RMC.

7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 3R in damp or wet locations.
8. Wiremold to be #3000 series raceway.

3.04 INSTALLATION:

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
C. Complete raceway installation before starting conductor installation.
D. Comply with requirements in SECTION 26 05 29 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS for hangers and supports.
E. Install no more than the equivalent of 360-degrees of bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
F. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
G. Support conduit within 12 inches of enclosures to which attached.
H. Conduit installed above suspended ceilings shall comply with the following:
   1. Install exposed conduit work so as not to interfere with ceiling inserts, windows, doors, lights, ventilation ducts or outlets.
   2. Support exposed conduits by use of hangers, clamps, or clips. Support conduits on each side of bends and on spacing not to exceed NEC requirements.
I. Stub-ups to Above Recessed Ceilings:
   1. Use EMT or RMC for raceways.
   2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
J. 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.
K. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
L. Terminate conduits square to enclosures into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install locknuts hand tight plus 1/4 turn more. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
M. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
N. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
O. Conduits shall not cross pipe shafts, access openings or ductwork openings.
P. Support riser conduit at each floor level with clamp hangers.
Q. Field-bend conduit with benders designed for purpose so as not to distort nor vary internal diameter.
R. Size conduits as indicated, unless no size is indicated then size per NEC.

S. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

T. Install conduits so as not to damage or run through solid structural members. Avoid horizontal or cross runs in building partitions or side walls.

U. Expansion-Joint Fittings:
   1. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100ºF and that has straight-run length that exceeds 100 feet.
   2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
      a. Outdoor Locations Not Exposed to Direct Sunlight: 125ºF temperature change.
      b. Indoor Spaces Connected with Outdoors without Physical Separation: 125ºF temperature change.
   3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
   4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
   5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

V. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed luminaires, the final 24 inches for connection to equipment subject to vibration, noise transmission, or movement; and for transformers and motors in nonhazardous locations. Provide a "green" insulated equipment ground wire suitably sized per NEC 250.122 unless indicated otherwise in all flexible steel conduit.
   1. Use LFMC in damp or wet locations subject to severe physical damage.
   2. Use LFMC in damp or wet locations not subject to severe physical damage.
   3. Use LFMC in corrosive atmospheres.
   4. Use LFMC in locations subjected to water spray or dripping oil, water or grease.

W. Conduits in Concrete Slabs: Prohibited.

X. Exposed Conduits:
   1. Install exposed conduits and extensions from concealed conduit systems neatly and parallel with or at right angles to walls of building or structure.
   2. Install exposed conduit work so as not to interfere with ceiling inserts, windows, doors, lights, ventilation ducts, outlets and fire alarm devices.
   3. Support exposed conduits by use of hangers, clamps, or clips. Support conduits on each side of bends and on spacing not to exceed NEC requirements.
   4. Above requirements for exposed conduits also apply to conduits installed in space above suspended ceilings and in crawl spaces.

Y. Conduit Fittings:
   1. Provide locknuts for securing conduit to metal enclosures with a sharp edge for digging into metal and ridged outside circumference for proper fastening. Standard locknuts are not acceptable.

2. Provide threaded, nylon insulated bushings for terminating conduits which have flared bottom and ribbed sides, with smooth upper edges to prevent injury to cable insulation.
3. Provide threaded, grounding bushings of insulated type with copper set screw clamp type lay-in grounding terminal where required by NEC, where indicated or specified.
4. Provide miscellaneous fittings such as reducers, close nipples, 3 piece unions, split couplings, and plugs as required which are specifically designed for their particular application.
5. Provide grounding in accordance with SECTION 26 05 26 - GROUNDING.
6. Provide raintight hubs on all outdoor conduit that are terminated in a nonthreaded enclosure hole.
7. Provide identification of all raceways as specified in SECTION 26 05 53 - ELECTRICAL IDENTIFICATION.
8. EMT shall have galvanized compression type box connectors at all boxes.

Z. Provide seismic bracing such that the raceways will not collapse during a Seismic event.

3.05 INSTALLATION OF SURFACE METAL RACEWAYS AND WIREWAYS:

A. Conduit for feeders and branch circuit homeruns shall connect directly to the panelboard. Install wireways, surface raceways, enclosures, gutters, and troughs only where indicated on the drawings.

B. General: Mechanically assemble metal enclosures and surface metal raceways for conductors to form continuous electrical conductor, and connect to electrical boxes, fittings, and cabinets to provide effective electrical continuity and rigid mechanical assembly.

1. Provide only where indicated on Drawings. Avoid use of dissimilar metals throughout system to eliminate possibility of galvanic corrosion. Where dissimilar metals are in contact, coat all surfaces with corrosion inhibiting compound before assembling.
2. Install with a minimum 2-inch radius control at bend points.
3. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
4. Install expansion fittings in all raceways, surface metal raceways, and wireways wherever structural expansion joints are crossed.
5. Make changes in direction of surface metal raceway and wireway with proper fittings supplied by raceway manufacturer. No field bends of surface metal raceway or wireway sections will be permitted.
6. Properly support and anchor surface metal raceways for their entire length with structural materials. Surface metal raceways are not to span any space unsupported.
7. Use boxes as supplied by surface metal raceway manufacturer wherever junction, pull or devices boxes are required. Standard electrical "handy" boxes, etc. shall not be permitted for use with surface metal raceway installations.
8. Provide identification of all raceways as specified in SECTION 26 05 53 – ELECTRICAL IDENTIFICATION.
9. Provide tap location nameplates for wireways when used as auxiliary gutters as specified in SECTION 26 05 53 – ELECTRICAL IDENTIFICATION.
10. Ground wireways at 10-foot intervals per SECTION 26 05 26 – GROUNDING.

3.06 INSTALLATION OF ELECTRICAL BOXES AND FITTINGS:

A. General: Install electrical boxes, bushings, locknuts, nipples, connectors, sealing hubs, and fittings as required, indicated, in accordance with applicable requirements of NEC and in accordance with recognized industry practices to fulfill project requirements.
B. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
C. Coordinate installation of electrical boxes and fittings with wire/cable, wiring devices, and raceway installation work.
D. Provide weatherproof boxes for interior and exterior locations exposed to weather or moisture.
E. All boxes containing normal power, emergency power, and lighting circuits shall be identified as specified in SECTION 26 05 53 – ELECTRICAL IDENTIFICATION.
F. Provide knockout closures to cap unused knockout holes where blanks have been removed.
G. Install electrical boxes in only those locations which ensure ready accessibility to enclosed electrical wiring.
H. Maximum box size in a fire-rated wall shall be 4 inches by 4 inches square. Do not install boxes back-to-back in walls. In nonfire-rated and nonacoustic- rated walls, provide not less than 6 inches horizontal separation between boxes installed in opposite sides of wall. Provide not less than 24 inches horizontal separation between boxes installed in opposite sides of fire-rated and acoustic- rated walls.
I. Position recessed outlet boxes accurately to allow for surface finish thickness.
J. Set floor boxes level and flush with finish flooring material.
K. Fasten electrical boxes firmly and rigidly to the surfaces to which attached, structural surfaces to which attached, or solidly embed them in concrete or masonry. Do not support boxes by conduits.
L. Provide electrical connections for installed boxes.
M. Locate boxes so that cover or plate will not span different building finishes.
N. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
O. Subsequent to installation of boxes, protect boxes from construction debris and damage.

3.07 GROUNDING:

A. Properly ground electrical boxes and demonstrate compliance with NEC 250 and NEC 517 requirements.

3.08 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS:

A. Comply with NECA 1.
B. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
    1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
        a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in SECTION 07 92 00 – JOINT SEALANTS.
        b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
    2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.

C. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

D. Aboveground, Exterior-Wall Penetrations: Seal penetrations using cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

3.09 SLEEVE AND CONDUIT SEAL SYSTEM INSTALLATION:

A. Install sleeve-seal systems in sleeves in exterior concrete walls at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

C. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

D. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Where otherwise required by NFPA 70.

E. Seal ducts and conduits at building entrances, and at outdoor terminations for equipment, with a nonhardening compound.

END OF SECTION 26 05 33

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SECTION 26 05 44 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

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:
   1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
   2. Sleeve-seal systems.
   3. Sleeve-seal fittings.
   4. Grout.
   5. Silicone sealants.

1.03 RELATED REQUIREMENTS:

A. DIVISION 07, SECTION "PENETRATION FIRESTOPPING" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.04 SUBMITTALS:

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 SLEEVES:

A. Refer to details on electrical drawings.

2.02 SLEEVE-SEAL SYSTEMS:

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
   1. Manufacturers: Subject to compliance with requirements.
   2. Basis-of-Design Product: Subject to compliance with requirements:
      a. Advance Products & Systems, Inc.
      b. CALPICO, Inc.
      c. Metraflex Company (The).
      d. Pipeline Seal and Insulator, Inc.
      e. Proco Products, Inc.
   3. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   4. Pressure Plates: Stainless steel.
   5. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.03 SLEEVE-SEAL FITTINGS:

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

1. Manufacturers: Subject to compliance with requirements.
2. Basis-of-Design Product: Subject to compliance with requirements:
   a. Presealed Systems or equal.

2.04 GROUT:

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
D. Packaging: Premixed and factory packaged.

2.05 SILICONE SEALANTS:

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
   1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
   2. Sealant VOC content calculated according to 40 CFR 59, Subpart D (EPA Method 24).
B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.01 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS:

A. Comply with NECA 1.
B. Comply with NEMA VE 2 for cable tray and cable penetrations.
C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
   1. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
   2. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
   3. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
   4. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.
D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
   1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
   2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.02 SLEEVE-SEAL-SYSTEM INSTALLATION:

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.03 SLEEVE-SEAL-FITTING INSTALLATION:

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 26 05 44

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SECTION 26 05 53 – ELECTRICAL IDENTIFICATION

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 specifies electrical identification work including the following:
   1. Buried cable and duct bank warnings.
   2. Electrical power, control, and communication conductors (and raceways).
   3. Operational instructions and warnings.
   4. Danger, caution and warning signs.
   5. Equipment/system identification nameplates.

1.03 RELATED REQUIREMENTS:

A. SECTION 26 05 73 – OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY.

1.04 REFERENCE STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. Applicable Standards: Comply with the applicable requirements of the following standards.
   1. ASTM International (ASTM):
      a. ASTM D709 - Standard Specification for Laminated Thermosetting Materials.
   2. National Electrical Manufacturers Association (NEMA):
      a. Z535.1 – Safety Colors.
      b. Z535.4 – Product Safety Signs and Labels.
   3. National Fire Protection Association (NFPA):
      a. 70 - National Electrical Code (NEC), as applicable to installation of identifying labels and markers for wiring and equipment.
      b. 70E – Standard For Electrical Safety In The Workplace.
      c. 72 – National Electric Safety Code (NESC) – IEEE C2.
   4. Occupational Safety and Health Administration (OSHA):
      a. 29 CFR 1910.144 – Safety Color Code for Marking Physical Hazards.
      b. 29 CFR 1910.145 - Specifications for Accident Prevention Signs and Tags.
   5. Underwriters Laboratories (UL), pertaining to electrical identification systems:
      a. 969-1995 – Standards for Marking and Labeling Systems.- Fourth Edition; Reprint with Revisions Through and Including September 19, 2014.

1.05 SUBMITTALS:

A. Refer to DIVISION 01 for administrative and procedural requirements for submittals.

B. Includes, but not limited to, the following:
   1. Product Data: Submit manufacturer's data on electrical identification materials and products.
   2. Samples: Submit samples of each color, lettering style, and other graphic representation required for each identification material or system.

1.06 QUALITY ASSURANCE:

A. Comply with ASME A13.1 and IEEE C2.
B. Comply with NFPA 70.
C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
D. Comply with NEMA Z535.4 – Product Safety Signs and Labels.
E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.07 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. Subject to compliance with requirements, provide electrical identification products of one of the following (for each type marker):
   1. Brady Worldwide, Inc.
   2. Panduit Corp.
   3. Seton Identification Products.
   4. Thomas & Betts Corp.
   5. Dymo, Inc.

2.02 TELECOMMUNICATIONS AND SECURITY CONDUIT SYSTEM IDENTIFICATION PRODUCTS:

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
   1. Dymo, Inc.
   2. Panduit, Inc.
B. Accessible Raceways and Fittings for Telecommunication and Security Systems: Identify the cover of junction and pull boxes of the following systems with the system name. Identify accessible, dedicated systems in raceways at each end before raceways transition to another room or floor. Systems legends shall be as follows:
   1. “TELECOM”
   2. “NURSE CALL”
   3. “SECURITY”
   4. “DAS”
C. Raceways dedicated for telecommunications and security cabling shall be provided with identification labels as follows:
   1. Wrap-around self-adhesive raceway labels or self-adhesive flat labels for covers.
   2. Self-extinguishing top-coated polyvinylidene fluoride film with a pressure-sensitive adhesive.

3. Print Method: Laser and ink-jet printing.
4. Adhesive: Acrylic-based, pressure-sensitive permanent adhesive.
5. Color: Clear film with YELLOW print-on area, text shall be BLACK in color.
6. Size: 1/2 -inch high letters on 1-1/2 inch high label.
7. Minimum application temperature: 50 degrees Fahrenheit (10 degrees Celsius).

2.03 ELECTRICAL IDENTIFICATION MATERIALS:

A. General: Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is Installer's option; but provide single selection for each application.

B. Self-Adhesive Plastic Signs:
   1. General: Self-adhesive or pressure-sensitive, preprinted, flexible vinyl signs for operational instructions or warnings; of sizes suitable for application areas and adequate for visibility, with proper wording for each application, e.g., "EXHAUST FAN."
      a. Colors: Unless otherwise indicated or required by governing regulations, provide white signs with black lettering.
   2. Electric Fire Pumps Signs:
      a. Sign at fire pump disconnect shall read: "Fire Pump Disconnecting Means."
      b. Sign at fire pump controller shall read: "Fire Pump Disconnect is located in Level 0 main electrical room."

C. Engraved Plastic-Laminate Nameplates:
   1. General: Engraving stock melamine plastic laminate nameplates, in sizes (minimum height of characters shall be 1/8 inch) and thicknesses specified or indicated, engraved with engraver's standard letter style of sizes and wording indicated, white face and black core plies (letter color) except as otherwise indicated, specified or required. Colors shall comply with OSHA and NEMA Z535.1. Nameplate shall be punched for mechanical fastening except where adhesive mounting is necessary because of surface it is mounted to.
      a. Thickness: 1/16-inch, for units up to 20 square inches or 8 inch length; 1/8-inch for larger units.
      b. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate surface it is mounted to.
   2. Lettering and Graphics:
      a. Coordinate names, abbreviations, and other designations used in electric identification work with corresponding designations shown, specified, or scheduled. Provide numbers, lettering, and wording as indicated or, if not otherwise indicated, as recommended by manufacturer, or as required for proper identification and operation/maintenance of electrical systems and equipment. Comply with ASME A13.1 pertaining to minimum sizes for letters and numbers. Comply with OSHA and NEMA Z535.4 requirements.

PART 3 - EXECUTION

3.01 APPLICATION AND INSTALLATION:

A. General Installation Requirements:
   1. Install electrical identification products as indicated, in accordance with manufacturer's written instructions and requirements of NEC.

2. Coordination: Where identification is to be applied to surfaces which require finish painting, install identification after completion of painting.
3. Regulations: Comply with governing regulations and requests of governing authorities for identification of electrical work.

B. Warning Signs:
1. Provide an orange background sign with black letters reading "WARNING: LOAD SIDE OF SWITCH MAY BE ENERGIZED BY BACKFEED" on all tie switches and tie circuit breakers.
2. Provide Arc Flash Warning signs on electrical equipment such as switchboards, switchgear, panelboards, transfer switches, industrial control panels, motor control centers and meter socket enclosures that are likely to require examination, adjustment, servicing, or maintenance while energized. Marking shall be permanently affixed and of a durable nature to withstand the environment within which it is installed.
3. Provide Available Fault Current Warning signs on electrical equipment as specified in SECTION 26 05 73. Label shall include possible incident energy exposure within arc flash boundary in front of equipment as well as meet NFPA 70E for additional content.

C. Caution Signs:
1. Provide the following yellow background caution sign with black letters on all panelboards, substations, switches, circuit breakers, and switchboards where turning off a circuit will automatically start an emergency generator:
   a. "Caution Turning Off this Circuit will Automatically Start Emergency Generator."
2. Provide the following yellow background caution sign with black letters on all automatic transfer switches, switches, circuit breakers, equipment, and emergency panelboards that are energized by the emergency power system:
   a. "Caution Automatically Energized by the Emergency Power System."

D. Equipment/System Identification Nameplates:
1. General: Install engraved plastic-laminated nameplates on each major unit of electrical equipment in the building; including central or master unit of each electrical system including communication/control/signal/alarm systems, unless unit is specified with its own self-explanatory identification or signal system. Except as otherwise indicated, provide single line of text, 1/2-inch high lettering on 1-1/2-inch high sign (2 inches high were two lines are required), black lettering on white field. Provide text matching terminology and numbering of the contract documents and shop drawings. Nameplate shall include unit designation, normal source circuit number ("Fed from..."), circuit voltage, and other data specifically indicated. Nameplate shall indicate normal source circuit number ("Fed from..."), and emergency source circuit number ("Fed from..."), when the equipment is a transfer switch or fed directly from a transfer switch. Provide nameplates for each unit of the following categories of electrical work:
   a. Switchboards, panelboards, electrical cabinets, and enclosures. (Include main bus ampacity on the nameplate.)
   b. Access panel/doors to electrical facilities.
   c. Major electrical switchgear (Include main bus ampacity on the nameplate.)
   d. Disconnect switch.
   e. Push buttons, selector switches, indicating lights. (Circuit number and voltage not required on nameplate).
   f. Lighting control equipment and contactors.
   g. Remote controlled switches, dimmer modules, and control devices.

h. Transformers (Include primary voltage, secondary voltage, number of phases, feeder, and panelboards or equipment supplied by the secondary.)
i. Inverters. (Include input voltage, output voltage, number of input phases.)
j. Battery racks.
k. Power generating units.
l. Telephone cabinets and switching equipment. (Circuit number and voltage not required on nameplate.)
m. Fire alarm and mass notification systems master station.
n. Security monitoring master station.
o. Uninterruptible power supplies (UPS).
p. Wireway used as auxiliary gutter tap locations with circuit number of circuit being tapped. Provide on outside of wireway.
q. Switchboard main switches and circuit breakers.

2. Install markers, tags, nameplates, and signs at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. Secure the identification with fasteners, except use adhesive where fasteners should not or cannot penetrate surface.

END OF SECTION 26 05 53

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SECTION 26 05 73 - OVERCURRENT PROTECTIVE DEVICE 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.

B. An engineer reviewed and approved overcurrent protective devices study shall be required prior to review of electrical equipment in SECTIONS: 26 22 13, 26 23 00, 26 23 13, 26 24 13 and 26 24 16.

1.02 SUMMARY:

A. This SECTION includes computer-based, fault-current, overcurrent protective device coordination, and arc-flash studies. Protective devices shall be set based on results of the studies.
   1. Series-rated devices are not permitted.

B. Contractor shall engage a qualified Short Circuit / Coordination / Arc-Flash Study consultant. Results of studies shall be in electronic format to incorporate into the overall campus model.
   1. Contractor shall supply all requested information necessary for completion of studies and incorporation.

1.03 SUBMITTALS:

A. The following preliminary submittals shall be provided with the initial electrical system protective devices equipment submittal. Preliminary submittals shall be approved prior to release of electrical equipment for purchase. Submittals shall be in digital form and shall be prepared under the supervision of a qualified professional engineer.
   1. Study input data, including completed computer program input data sheets.
   2. One-line diagram, showing the following:
      a. Protective device designations and ampere ratings.
      b. Cable size and lengths.
      c. Transformer kilovolt ampere (kVA) and voltage ratings.
      d. Motor and generator designations and kVA ratings.
      e. All equipment designations.
   3. Fault Current Study Report.
   4. Coordination-Study Report.
   5. Equipment Evaluation Reports.

B. The following submittals shall be made after the electrical system protective devices have been submitted, approved, and installed. Submittals shall be in digital form.
   1. Final study input data, including executive summary, purpose, basis, scope, and completed computer program input data sheets.
   2. Final One-line diagram indicating installed condition of electrical systems, including:
      a. Protective device designations and ampere ratings.
      b. Cable size and lengths.
      c. Transformer kilovolt ampere (kVA) and voltage ratings.
      d. Motor and generator designations and kVA ratings.
      e. All equipment designations.
   3. Final Fault Current Study Report; signed, dated, and sealed by a qualified professional engineer.
   4. Final Coordination-Study Report; signed, dated, and sealed by a qualified professional engineer.

a. Include finalized coordination curves.
5. Final Arc-Flash Study Report; signed, dated, and sealed by a qualified professional engineer.
6. Arc-Flash labels shall be printed and placed on all electrical equipment.
7. Final Study Reports, including:
a. Interrupting duty report.
b. Equipment evaluation report
c. Incident Energy and Flash Protection Boundary Report
d. Final Overcurrent Protection Device settings report.

C. Provide a hard copy and digital copy on compact disc (CD) or digital versatile disc (DVD) of the final Study, including Coordination Study, Fault Current Study, Short-Circuit Study, Arc Flash studies, final reports, and all software files used for calculations therein. Digital copy shall be compiled using Project-Backup command within SKM PowerTools software program to provide all project electrical model information.

D. Qualification Data: For coordination-study specialist.

1.04 QUALITY ASSURANCE:

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this SECTION. Manual calculations are 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. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 399 for general study procedures.

E. Comply with NFPA 70E.

PART 2 - PRODUCTS

2.01 COMPUTER SOFTWARE DEVELOPERS

A. Computer Software Developers:
1. SKM Systems Analysis, Inc., Latest version.

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.
1. Optional Features:
a. Arcing faults.
b. Simultaneous faults.
c. Explicit negative sequence.

d. Mutual coupling in zero sequence.

2.03 ARC-FLASH WARNING LABELS

A. Comply with requirements in SECTION 26 05 53 ELECTRICAL IDENTIFICATION. Produce a 3.5-by-5-inch waterproof thermal transfer label of high-adhesion polyester for each work location included in the analysis.

B. The label for incident energy values less than or equal to 40 cal/cm^2 shall have an orange header and black lettering with the wording, "WARNING, ARC-FLASH HAZARD." The label for incident energy values greater than 40 cal/cm^2 shall have a red header and black lettering with the wording, "DANGER, ARC-FLASH HAZARD." Labels shall include the following information taken directly from the arc-flash hazard analysis:
   1. Location designation.
   2. Nominal voltage.
   3. Flash protection boundary.
   4. Hazard risk category.
   5. Incident energy.
   6. Working distance.
   7. Engineering report number, revision number, and issue date.

C. Labels shall be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated shall be the devices required by NFPA 70 and NFPA 99, including but not limited to, all devices which make up the essential electrical system which consists of the life safety branch, critical branch, and equipment branch.
   1. Proceed with coordination study only after relevant equipment submittals have been assembled. Submit preliminary studies at the same time as equipment submittals for concurrent review.
   2. Overcurrent protective devices that have not been submitted and approved prior to final coordination study may not be used in study.

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.

4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
   a. Special load considerations, including starting inrush currents and frequent starting and stopping.
   b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
   c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
   d. Generator thermal-damage curve.
   e. Ratings, types, and settings of utility company's overcurrent protective devices.
   f. Special overcurrent protective device settings or types stipulated by utility company.
   g. Time-current-characteristic curves of devices indicated to be coordinated.
   h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
   i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
   j. Electrical equipment ampacity and interrupting rating in amperes rms symmetrical.

3.03 FAULT-CURRENT STUDY:

A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each point in the electrical system.

B. 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. Reference normal and essential system sequence of operations in SECTION 26 23 13 PARALLELING LOW VOLTAGE SWITCHGEAR.
   1. Final fault current study shall consider final installed and approved normal and essential electrical system operating sequence.

C. Perform study following the general study procedures contained in IEEE 399 and IEEE 551.

D. The study shall show that each new overcurrent protective device in the electrical distribution system is applied within its fault current rating.

E. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low- and medium-voltage, three-phase ac systems.

F. Base study on the device characteristics supplied by device manufacturer.

G. Begin analysis at the service entrance points and extend down to the system overcurrent protective devices as follows:
   1. To normal system low-voltage load buses where fault current is 10 kA or less.

H. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 141 and IEEE 242.
   1. Transformers:
      a. ANSI C57.12.10.
      b. ANSI C57.12.22.
      c. ANSI C57.12.40.
      d. IEEE C57.12.00.
      e. IEEE C57.96.
   2. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
   3. Low-Voltage Fuses: IEEE C37.46.

I. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
   1. Voltage.
   2. Calculated symmetrical fault-current magnitude and angle.
   3. Fault-point X/R ratio.
   4. No AC Decrement (NACD) ratio.
   5. Equivalent impedance.
   6. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
   7. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.
   8. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
   9. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium- and high-voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.

J. Equipment Evaluation Report:
   1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
   2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
   3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.04 COORDINATION STUDY:

A. Perform coordination study using approved computer software program. Prepare time current curves plotted in full scale log-log graph on color printed paper. Curves for adjustable devices shall be shown adjusted to afford maximum coordination with upstream and downstream devices. Upstream devices shall include the power company's upstream devices provided by the power company and Normal power devices located on the line side of automatic transfer switches. Provide a narrative discussion for each protective device and describe any areas where there are difficulties achieving selectivity. Comply with IEEE 399.
   1. Final Overcurrent Protection Device settings report in tabular format:
      a. Device tag.
      b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
      c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.

d. Fuse-current rating and type.
e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared in graphical color format to illustrate settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Essential electrical system devices shall be selectively coordinated to 0.1 seconds. The Essential electrical system is comprised of the Life Safety, Critical, and Equipment power branches. Include the following information:
   a. Device tag.
   b. Voltage and current ratio for curves.
   c. Three-phase and single-phase damage points for each transformer.
   d. No damage, melting, and clearing curves for fuses.
   e. Cable damage curves.
   f. Transformer inrush points.
   g. Maximum fault-current cutoff point.

B. Comply with IEEE 141 recommendations for fault currents and time intervals.

C. Transformer Primary Overcurrent Protective Devices:
1. Device shall not operate in response to the following:
   a. Inrush current when first energized.
   b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
   c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

D. 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 circuit breaker 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.

E. Completed data sheets for setting of overcurrent protective devices.

3.05 OVERCURRENT PROTECTIVE DEVICE SETTING

A. Manufacturer's Field Service: Engage a factory-authorized service representative, of electrical distribution equipment being set and adjusted, to assist in setting of overcurrent protective devices within equipment.

B. Testing: Perform the following device setting and prepare reports:
1. After installing overcurrent protective devices and during energizing process of electrical distribution system, perform the following:
   a. Verify that overcurrent protective devices meet parameters used in studies.
   b. Adjust devices to values listed in study results.
2. Adjust devices according to recommendations in Chapter 7, "Inspection and Test Procedures," and Tables 10.7 and 10.8 in NETA ATS.

3.06 ARC-FLASH HAZARD ANALYSIS

A. Comply with IEEE 1584 and NFPA 70E and its Annex D for hazard analysis study.

B. Use the fault current study output and the field-verified settings of the overcurrent devices.
C. Calculate maximum and minimum contributions of fault-current size.
   1. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume no motor load.
   2. The maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
D. Calculate the arc-flash protection boundary and incident energy at locations in the electrical distribution system where personnel could perform work on energized parts or operate electrical equipment.
E. Incident Energy and Flash Protection Boundary Report shall include:
   1. Arcing fault magnitude.
   2. Protective device clearing time.
   3. Duration of arc.
   4. Arc-flash boundary.
   5. Working distance.
   6. Incident energy.
   7. Hazard risk category.
   8. Recommendations for arc-flash energy reduction.
F. Safe working distances shall be specified for calculated fault locations based on the calculated arc-flash boundary, considering incident energy of 1.2 cal/sq.cm.
G. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:
   1. Fault contribution from induction motors should not be considered beyond three to five cycles.
   2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).
H. Arc-flash computation shall include both line and load side of a circuit breaker as follows:
   1. When the circuit breaker is in a separate enclosure.
   2. When the line terminals of the circuit breaker are separate from the work location.
I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.
J. With the exception of the service entrance main breaker, the incident energy available shall be reduced as low as practical, but no higher than 8.0 cal/cm^2 while maintaining coordination.

3.07 ARC-FLASH LABELING

A. Install the arc-fault warning labels under the direct supervision and control of the Arc-Flash Study consultant.
B. Apply one arc-flash label for each 600-V ac, 480-V ac, and 208-V ac piece of electrical equipment, including:
   1. Distribution panels.
   2. Branch circuit panels.
   3. Distribution transformers.
   4. Transfer switches.
   5. Paralleling Switchgear.

3.08 DEMONSTRATION

A. Engage the Arc-Flash Study consultant to train Owner's maintenance personnel in the potential arc-flash hazards associated with working on energized equipment and the significance of the arc-flash warning labels.

END OF SECTION 26 05 73

SECTION 26 08 00 – ELECTRICAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.01 WORK INCLUDES:

A. Validation of proper installation of DIVISIONS 26, 27, and 28 systems and equipment
B. Systems and equipment testing and startup
C. Equipment performance verification
D. Functional testing of control systems
E. Documentation of tests, procedures and installations
F. Coordination of training

1.02 SCOPE INCLUDES:

A. Systems to be commissioned include the following:
   1. Emergency Power Distribution
   2. Normal Power Distribution
   3. Grounding Systems
   4. Lightning Protection Systems (Commissioning by MU)
   5. Lighting and Controls (Commissioning by MU)
   6. Access Control System (Commissioning by MU)
   7. Nurse Call System (Commissioning by MU)
   8. Fire Detection and Alarm System

1.03 RELATED DOCUMENTS:

A. Commissioning Plan - This plan is part of the Contract Documents and outlines many responsibilities, procedures and tasks throughout the commissioning process.
B. SECTION 01 91 13 – GENERAL COMMISSIONING REQUIREMENTS
C. SECTION 23 08 00 – MECHANICAL COMMISSIONING REQUIREMENTS
D. DIVISION 26 SECTIONS - Individual Sections stipulate installation, startup, warranty and training requirements for the system or device specified in that SECTION.
E. DIVISION 27 SECTIONS - Individual Sections stipulate installation, startup, warranty and training requirements for the system or device specified in that SECTION.
F. DIVISION 28 SECTIONS - Individual Sections stipulate installation, startup, warranty and training requirements for the system or device specified in that SECTION.

1.04 REFERENCES:

A. ASHRAE Guideline 0-2013: The HVAC Commissioning Process.
B. ANSI/NEBB Standard S110-2019 – Second Edition – Whole Building Technical Commissioning

1.05 GENERAL DESCRIPTION:

A. Commissioning is a process to assure all building systems are installed and perform interactively according to the design intent; the systems are efficient, cost effective and meet the Owner's operational needs; the installation is adequately documented; and operating personnel are adequately trained. Commissioning serves as a tool to minimize post-occupancy operational problems. It establishes testing and communication protocols in an effort to advance building systems from installation to fully optimized operation.
B. The Commissioning Authority will work with the Contractor and Design Engineer to coordinate, oversee, and document the commissioning process during the Construction Phase of

this project.

C. This SECTION defines responsibilities of the Contractor to facilitate the commissioning process particularly during the Construction Phase of the project.

1.06 DEFINITIONS:

A. Refer to specification SECTION 01 91 13 for definitions related to the commissioning process.

1.07 DOCUMENTATION:

A. Contractor shall send Commissioning Authority one copy of the following per the procedures specified in other sections of the Specification:
   1. Shop drawings and product data related to systems and equipment to be commissioned on this project. CxA will review and incorporate comments via the Design Engineer.
   2. Initial draft of equipment startup plan checklists along with manufacturers' startup procedures. CxA will assist in development and recommend approval.
   3. System Test Reports. CxA will review and compile prior to FPT.
   4. System certificate of readiness including completed equipment startup forms along with the manufacturers' field or factory performance test documentation. CxA will review and approve prior to FPT.
   5. Equipment Warranties.
   6. Training Plans.
   7. O&M documentation per requirements of the Commissioning Plan and the Specifications, DIVISION 01.
   8. Record Drawings: Contractor shall maintain at the site an updated set of record or "as-built" documents reflecting actual installed conditions. As-built drawings will be updated in electronic format by the Contractor and submitted to the CxA on a regular basis.

1.08 SEQUENCING AND SCHEDULING:

A. Systems can be in various stages of the commissioning process where appropriate, in order to expedite close out of the facility. The CxA and Contractor shall cooperate to schedule Cx tasks to minimize the duration of Cx activities. Sequential priorities shall be followed per the Cx Plan.

B. Commissioning Schedule - Contractor shall incorporate the commissioning process into the project schedule. Startup, TAB and FPT shall be itemized as applicable for each system. Durations for each task shall be coordinated with the CxA.

1.09 COORDINATION MANAGEMENT PROTOCOLS:

A. Coordination responsibilities and management protocols relative to Cx are initially defined in the Cx Plan but will be refined and documented at the commissioning scoping meeting. Contractor shall have input to the protocols and all parties will commit to scheduling obligations. The CxA will record and distribute notes from the meeting.

1.10 COMMISSIONING AUTHORITY RESPONSIBILITIES:

A. Construction Phase
   1. Plan and conduct commissioning scoping meeting
   2. Review applicable project documentation (shop drawings, product data, TAB reports, O&M information, record drawings, etc.) for adequacy and to verify system functionality.
   3. Review and approve startup checklist forms.
   4. Inspect equipment and system installations periodically.

5. Attend selected planning meetings to observe progress and help expedite completion.
6. Witness selected tests, startups and equipment training.

B. Acceptance Phase
1. Analyze trend logs.
2. Functionally test systems and equipment.
3. Review training plan.
4. Assist the contractor in the coordination of training activities.
5. Record commissioning procedures.

1.11 CONTRACTOR RESPONSIBILITIES:

A. Construction Phase
1. Include commissioning requirements in price and plan for work.
2. Attend scoping and coordination meetings scheduled by the CxA.
3. Remedy deficiencies identified during the construction period.
4. Prepare and submit required draft forms and equipment information requested by the CxA. Typically this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation, start-up and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the CxA.
5. Assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
6. Provide limited assistance to the CxA in preparing the specific functional performance test procedures. Contractors shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
7. Where functional testing is to be executed by the system/equipment provider (see "Systems/Equipment to be Commissioned") the Contractor, with the CxA's assistance, will develop final functional test checklists for each system, subsystem, or equipment including interfaces and interlocks, and include a separate entry, with space for comments, for each item to be tested.
8. Thoroughly complete and inspect installation of systems and equipment in accordance with the Contract Documents, reference or industry standards, and specifically Part 3 of this SECTION.
9. Startup systems and equipment prior to verification and performance testing by the CxA. Startup procedures shall be in accordance with Contract Documents, reference or industry standards, and specifically Part 3 of this SECTION.
10. Record startup and test procedures on startup forms and checklists and certify the systems and equipment have been started and tested in accordance with the Contract Documents, reference or industry standards, and specifically Part 3 of this SECTION. Each form shall be signed and dated by the individual responsible for the startup or test.
11. Complete pre-approved startup checklists and submit along with other installation certification documentation such as certificate of readiness, warranties, test results, etc.
12. Schedule and coordinate Cx efforts required by appropriate subcontractors and vendors. Participate in respective portions of start-ups and training.

13. Demonstrate the systems as specified.
14. Certify systems have been installed and are operating per Contract Documents through certificates of readiness.
15. Maintain an updated set of record documentation.
16. Copy CxA on indicated documentation.
17. Conduct equipment operation, maintenance, diagnosis and repair training as required by the respective section of the Specifications.

B. Acceptance Phase
1. Assist CxA in verification and performance testing. Assistance will generally include the following:
   a. Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.
   b. Manipulate systems and equipment to facilitate testing.
   c. Manipulate control systems to facilitate verification and performance testing.
2. Correct any work not in accordance with Contract Documents and non-conformances included in the commissioning issues log.
3. Participate in the systems and operational training as it relates to O&M information and the Preventative Maintenance (PM) program.

C. Warranty Phase
1. Provide warranty service.
2. Participate in the opposite season and deferred functional testing.
3. Correct any deficiencies identified.
4. Update record documentation to reflect any changes made throughout the Warranty Phase.

1.12 CONTRACTOR NOTIFICATION:

A. Contractor shall completely install, thoroughly inspect, startup systems and equipment. All activities shall be documented on specified forms. Contractor shall notify Design Engineer, Owner and CxA via the certification of readiness that systems are complete and ready for verification and functional performance testing.

B. Contractor shall notify CxA at least 10 business days in advance of any tests, startups or training. CxA shall witness selected tests and startups.

1.13 STARTUP CHECKLISTS:

A. Startup checklists for each type of equipment and system shall be submitted to CxA for approval prior to startup. The forms shall be designed by the appropriate subcontractors or vendors to meet the requirements of the Contract Documents. Forms shall be developed for the specific equipment being installed for this project.

B. Startup checklists shall generally include the following for each (as applicable):
1. Project specific designation, location and service
2. Pertinent nameplate data
3. Indication of the party performing the test
4. Field for signature of the startup technician along with the date
5. Clear explanation of the inspection, test, measurement, etc. with a pass/fail indication and a record of measurement parameters
6. Checklist space that proper maintenance clearances have been maintained

7. Checklist space indicating that any required special tools and/or spare tools were turned over to the Owner
8. Checklist space indicating that required prerequisite equipment and systems were successfully started.

C. Startup checklists shall incorporate the manufacturer-specified procedures. Contractor shall compile the startup and checkout procedures indicated in the manufacturer's documentation prior to designing the forms. Include specified acceptance criteria as applicable. The manufacturer's startup and checkout procedures shall be submitted to the CxA along with the draft startup checklists.

D. Completed startup plans for all pieces of equipment included in a system shall be submitted to CxA prior to verification and performance testing.

E. See specification 019113 for additional information regarding Startup Checklists.

1.14 FUNCTIONAL PERFORMANCE TESTING:

A. Participation: CxA will coordinate, test and/or witness functional performance tests after the successful startup and documentation of systems and equipment is complete. Contractor shall assist, as described above, with manipulation of the systems or equipment; provision of supporting equipment or materials (lifts, ladders, specialty test equipment, etc.); and on the spot remediation of minor identified deficiencies.

B. Detailed Test Forms: CxA will prepare detailed testing procedures and forms to conduct and document the FPT. These will be developed during the Construction Phase and completed during the Acceptance Phase.

C. Test Documentation: CxA will record test results on the forms developed for the testing. CxA will Pass or Fail the testing and record the date and time of the test. Deficiencies shall clearly indicate when the test has failed. CxA shall recommend acceptance of the system or component after all related testing is successfully complete.

D. Deficiencies and Retesting: When deficiencies are identified during testing, depending on their extent or magnitude, they can be corrected during the test and the testing can continue to successful completion. Significant deficiencies will fail the test and require retesting of the affected portions of the test. The CxA will subsequently track the resolution of the deficiency via the Project Deficiency List. All tests shall be repeated until successful completion.

E. Opposite Season Testing: Testing procedures shall be repeated and/or conducted as necessary during appropriate seasons. "Opposite season" testing will be required where scheduling prohibits thorough testing in all modes of operation.

1.15 TRAINING:

A. Contractors shall prepare and conduct training sessions on the installed systems and equipment for which they are responsible.

B. Contractor shall compile the training plans of the subcontractors and vendors and present a comprehensive training plan as outlined in SECTION 01 79 00.

C. Equipment Specific Training: The appropriate Contractor shall instruct the Owner's designated representative on the safe and proper operation, maintenance, diagnosis and repair of each piece of equipment. Submitted O&M information shall be used during training. Sessions shall include as a minimum:

1. Conceptual overview of how the equipment works
2. Contact information including names, addresses, phone numbers, etc. of sources for equipment information, tools, spare parts, etc.
3. Details of the warranty or guarantee

4. Intended sequences of operation in all modes of operation
5. Limits of responsibility (ex: unit mounted control vs. building management system)
6. Sources of utility support
7. Routine operator tasks involving monitoring and operation covering all modes of operation and mode switching as applicable
8. Relevant health and safety practices/concerns
9. Common problems and their diagnosis and repair
10. Proper maintenance schedules, tasks and procedures with demonstrations
11. Emergency response, documentation and recovery procedures

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.01 GENERAL:

A. This SECTION outlines specific startup, checkout, and functional testing requirements for systems and equipment. Generally these procedures are the direct responsibility of the Contractor as a basic element of validating that the installation is correct. These requirements along with those specified in the individual Section provide a minimum guideline for development of startup procedures, checklists and tests. Contractor shall synthesize these requirements with that of the manufacturer's and/or applicable codes and standards to develop specific and itemized startup procedures specific to that installed on this project.

B. Refer to all DIVISION 26 Specifications for tests performed on installed equipment and systems.

C. Refer to all DIVISION 27 Specifications for tests performed on installed equipment and systems.

D. Refer to all DIVISION 28 Specifications for tests performed on installed equipment and systems.

3.02 STARTUP:

A. The contractor shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this SECTION and in 01 91 13. The Contractor has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the commissioning authority or Owner.

B. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the CxA and Contractor. Beginning system testing before full completion does not relieve the Contractor from fully completing the system, including all startup plan checklists as soon as possible.

3.03 STARTUP/CHECKOUT:

A. Verify that equipment testing work is complete before starting functional performance of power equipment.

B. Inspect equipment and confirm that it is clean and ready for operation. All shipping tags removed, nameplates installed and equipment manuals in place.

C. Verify all equipment labeling corresponds with drawings and indices and meets required

Specifications. Correct any deficiencies for electrical systems.

3.04 NORMAL POWER DISTRIBUTION – STARTUP/CHECKOUT:

A. Overcurrent protective device settings coordinated and adjusted per the study results.
B. System in place and tested, including all components indicated.
C. Connected to utility company power system on a permanent basis.
D. Wiring installed in conduits.
E. System checked for unwanted grounds, short circuits or open circuits.
F. Ground installed as indicated, including transformers.
G. Equipment connections properly torqued.
H. Equipment, where indicated, on housekeeping pads.
I. Equipment cleaned and shipping blocks removed.
J. Equipment labeled.
K. Boxes and nameplates meet color coding requirements.

3.05 EMERGENCY POWER DISTRIBUTION – STARTUP/CHECKOUT:

A. System in place and tested, including all components indicated.
B. Facility shall be connected to utility company power system on a permanent basis before emergency checklist is addressed.
C. Wiring installed in color coded conduits.
D. System checked for unwanted grounds, short circuits or open circuits.
E. Grounds installed as indicated, including transformers.
F. Ground fault settings made.
G. Equipment connections properly torqued.
H. Equipment, where indicated, on housekeeping pads.
I. Equipment cleaned and shipping blocks removed.
J. All ATS delay and timer settings are programmed.
K. Equipment labeled.
L. Boxes and nameplates meet color coding requirements.
M. Proper phase rotation coordinated between emergency and normal sources.

3.06 LIGHTING CONTROLS – STARTUP/CHECKOUT (Commissioned by MU):

A. System in place and tested, including all components indicated.
B. Wiring installed in conduits or other raceways.
C. System check for unwanted grounds, short circuits or open circuits.
D. Grounds installed as indicated.
E. Equipment labeled.
F. Boxes and nameplates meet color coding requirements.
G. Connected to emergency power system where required.
H. New portion of system connected and interfaced with existing lighting control system.
I. Verify system has been inspected and given approval by jurisdictional authority.

3.07 NURSE CALL SYSTEM – STARTUP/CHECKOUT (Commissioned by MU):

A. System in place and tested, including all components indicated.
B. Connected to emergency power system.
C. Wiring is plenum rated where required.
D. Exposed Areas: Wiring installed in conduit.
E. System checked for grounds or breaks.

F. New portion of system connected and interfaced with existing hospital nurse call system.
G. Wiring installed in cable tray, or J-hooks, or bridal spring clips.
H. Cables have color coded identification tags.
I. Boxes and nameplates meet color coding requirements.
J. Verify system has been inspected and given approval by jurisdictional authority.

3.08 ACCESS CONTROL SYSTEM – STARTUP/CHECKOUT (Commissioned by MU):

A. System in place and tested, including all components indicated.
B. Connected to emergency power system.
C. Wiring installed in conduits or other raceways.
D. System check for unwanted grounds, short circuits or open circuits.
E. Grounds installed as indicated.
F. Equipment labeled.
G. Boxes and nameplates meet color coding requirements.
H. New portion of system connected and interfaced with existing security system.
I. Verify system has been inspected and given approval by jurisdictional authority.

3.09 FIRE ALARM SYTEM – STARTUP/CHECKOUT:

A. System in place and tested, including all components indicated.
B. Connected to emergency power system.
C. Wiring is plenum rated where required.
D. Wiring installed in color coded conduit.
E. System checked for grounds or breaks.
F. System connected to sprinkler alarm system and air handling systems.
G. Cables have color coded identification tags.
H. Boxes and nameplates meet color coding requirements.
I. Verify system has been inspected and given approval by jurisdictional authority.

3.10 FUNCTIONAL TESTING:

A. This SECTION specifies the functional testing requirements for DIVISION 26 systems and equipment. From these requirements, the Commissioning Authority (CxA) shall develop step-by-step procedures to be executed by the Contractors or the Commissioning Authority. The general functional testing process, requirements and test method definitions are described in SECTION 01 91 13. The test requirements for each piece of equipment or system contain the following:
    1. The contractors responsible to execute the tests, under the direction of the CxA
    2. A list of the integral components being tested
    3. Startup plan checklists associated with the components
    4. Functions and modes to be tested
    5. Required conditions of the test for each mode
    6. Special procedures
    7. Required monitoring
    8. Acceptance criteria
B. Prerequisites
    1. The following applicable generic prerequisite checklist items are required to be completed and submitted with the equipment/system certificate of readiness and checked off by CxA prior to functional testing.

2. All related equipment has been started up and startup plan checklists submitted and approved ready for functional testing.
3. All control system functions for this and all interlocking systems are programmed and operable per contract documents, including final setpoints and schedules with debugging, loop tuning and sensor calibrations completed.
4. Test and balance (TAB) complete and approved for the air and hydronic systems
5. All A/E punchlist items for this equipment corrected
6. Schedules and setpoints provided to the CxA
7. False loading equipment, system and procedures ready
8. Sufficient clearance around equipment for servicing

C. Monitoring
1. Monitoring is a method of testing as a stand-alone method or to augment manual testing.
2. All points listed in the required monitoring section of the test requirements which are control system monitored points shall be trended by the controls contractor. Other points shall be monitored by the CxA using dataloggers. At the option of the CxA, some control system monitoring may be replaced with datalogger monitoring. At the CxA's request, the controls contractor shall trend up to 20% more points than listed herein at no extra charge.
3. Trend output data must be in an ASCII delimited text file with time continuous down left column and point values in column(s) to the right.
4. All trends for points of a group must start at the same moment in time, unless specifically approved otherwise with the commissioning agent.

3.11 NORMAL POWER SYSTEMS FPT:

A. Parties Responsible to Execute Functional Test
1. Electrical contractor: perform functional testing
2. CxA: to witness, direct and document testing.
3. Equipment manufacturer's representative, as required.
4. Owner's Representative
5. Owner's maintenance staff, as desired.
6. Campus Energy Management

B. Prerequisites: The applicable prerequisite checklist items listed in paragraph 3.7.B shall be listed on each certificate of readiness form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the startup plan checklists previously completed by the installer, before the beginning of functional testing.

C. Functions / Modes Required to be Tested
1. Activate system by connection to utility power.
2. Verify voltages and amperes at meters on switchgear.
3. Verify voltages and amperes at switchgear, switchboards, motor control centers, panelboards, and transformers, both primary and secondary.
4. Verify voltages and amperes at mechanical motors and other major pieces of equipment.

D. Results: If specified equipment performance is not achieved, the Contractor shall have corrections made and reschedule Functional Performance Test as soon as possible after corrective work is completed.

E. Acceptance Criteria
1. For the conditions, sequences and modes tested, the system, integral components, and related equipment respond to varying loads and changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

END OF REQUIREMENTS FOR POWER SYSTEMS TEST

3.12 EMERGENCY POWER SYSTEMS FPT:

A. Parties Responsible to Execute Functional Test
   1. Electrical contractor: perform functional testing
   2. CxA: to witness, direct and document testing.
   3. Equipment manufacturer's representative, as required.
   4. Owner's Representative
   5. Owner's maintenance staff, as desired.

B. Prerequisites: The applicable prerequisite checklist items listed in paragraph 3.5.B shall be listed on each certificate of readiness form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the startup plan checklists previously completed by the installer, before the beginning of functional testing.

C. Functions / Modes Required to be Tested
   1. Activate system by manual transfer from utility power.
   2. Demonstrate automatic transfer of power.

D. Results: If specified equipment performance is not achieved, the Contractor shall have corrections made and reschedule Functional Performance Test as soon as possible after corrective work is completed.

E. Acceptance Criteria
   1. For the conditions, sequences and modes tested, the system, integral components, and related equipment respond to varying loads and changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

END OF REQUIREMENTS FOR EMERGENCY POWER SYSTEMS TEST

3.13 GROUNDING SYSTEM FPT:

A. Parties Responsible to Execute Functional Test
   1. Electrical contractor
   2. CxA: to witness, direct and document testing.
   3. Owner's Representative
   4. Owner's maintenance staff, as desired.

B. Prerequisites: The applicable prerequisite checklist items listed in paragraph 3.7.B shall be listed on each certificate of readiness form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the startup plan checklists previously completed by the installer, before the beginning of functional testing.

C. Functions / Modes Required to be Tested
   1. Conduct fall of potential ground resistance tests per IEEE Standard 81 at each test well and at service equipment.

D. Results: If specified equipment performance is not achieved, the Contractor shall have corrections made and reschedule Functional Performance Test as soon as possible after corrective work is completed.

E. Acceptance Criteria
   1. For the conditions, sequences and modes tested, the system, integral components, and related equipment respond to varying loads and changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

END OF REQUIREMENTS FOR GROUNDING SYSTEM TEST

3.14 LIGHTNING PROTECTION SYSTEM FPT:

A. Parties Responsible to Execute Acceptance Inspection
   1. Electrical contractor/ System installer
   2. Third-party UL-Qualified Special Inspector
   3. CxA: to witness, direct and document testing.
   4. Owner's Representative
   5. Owner's maintenance staff, as desired.

B. Prerequisites: The applicable prerequisite checklist items listed in paragraph 3.8.B shall be listed on each certificate of readiness form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items on the startup plan checklists previously completed by the installer, before the beginning of functional testing.

C. Functions / Modes Required to be Tested
   1. Test the lightning protection and grounding system and provide documentation for the measured values at each test point. Test the ground rod for resistance to ground before making connections to the rod. Tie the grounding system together and test for resistance to ground. Make resistance measurements in dry weather, not earlier than 48 hours after rainfall. Include in the written report: locations of test points, measured values for continuity and ground resistances, and soil conditions at the time that measurements were made.
   2. Inspection must cover every connection, air terminal, conductor, fastener, surge protection devices, accessible grounding point and other components of the lightning protection system to ensure 100% system compliance. Random sampling or partial inspection of a facility is not acceptable.
   3. Results: If specified equipment performance is not achieved, the Contractor shall have corrections made and reschedule Functional Performance Test as soon as possible after corrective work is completed.

D. Acceptance Criteria
   1. Testing of the lightning protection and grounding system ensure bonding continuity is not in excess of 1 ohm and that resistance to ground is not in excess of 25 ohms.
   2. Acceptance testing of surge protection devices shall be performed and documented per UFC 3-520-01.
   3. Per UFC 3-575-01, provide a UL Lightning Protection Inspection Certificate for each facility indicating compliance to NFPA 780, Chapter 8 including any additional requirements listed in Dept. of the Army PAM 385-64 and UFC 3-575-01 that may be more stringent.

END OF REQUIREMENTS FOR LIGHTNING PROTECTION SYSTEM TEST

3.15 LIGHTING CONTROL SYSTEM FPT:

A. Parties Responsible to Execute Functional Test
   1. Electrical contractor
   2. CxA: to witness, direct and document testing.
   3. Equipment manufacturer's representative, as required.
   4. Owner's Representative
   5. Owner's maintenance staff, as desired.

B. Prerequisites: The applicable prerequisite checklist items listed in paragraph 3.7.B shall be listed on each certificate of readiness form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the startup plan

checklists previously completed by the installer, before the beginning of functional testing.

C. Functions / Modes Required to be Tested
   1. Demonstrate operation of lighting control system per specifications including the following:
      a. Control switches
      b. Dimming performance
      c. Verify tie-in and proper system remote operation
      d. Verify system function upon loss of power

D. Results: If specified equipment performance is not achieved, the Contractor shall have corrections made and reschedule Functional Performance Test as soon as possible after corrective work is completed.

E. Acceptance Criteria
   1. For the conditions, sequences and modes tested, the system, integral components, and related equipment respond to varying loads and changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

END OF REQUIREMENTS FOR LIGHTING CONTROL SYSTEM TEST

3.16 NURSE CALL SYSTEM FPT:

A. Parties Responsible to Execute Functional Test
   1. Electrical contractor
   2. CxA: to witness, direct and document testing.
   3. Equipment manufacturer's representative, as required.
   4. Owner's Representative
   5. Owner's maintenance staff, as desired.

B. Prerequisites: The applicable prerequisite checklist items listed in paragraph 3.8.B shall be listed on each certificate of readiness form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the startup plan checklists previously completed by the installer, before the beginning of functional testing.

C. Functions / Modes Required to be Tested
   1. Demonstrate operation of nurse call system per specifications including the following:
      a. Alarm initiating devices including code blue, emergency stations, pull stations, patient bed stations, pillow speaker controllers, and bed side-rail control.
      b. Staff, duty and sub stations.
      c. Nurse Call master stations.
      d. Patient entertainment interface.
      e. Notification devices, visual and audible.
      f. Staff locator system.
      g. Verify tie-in and proper system operation with any connection of interface with other building systems.
      h. Management software and wireless telephone interface.
      i. Verify system function upon loss of power.

D. Results: If specified equipment performance is not achieved, the Contractor shall have corrections made and reschedule Functional Performance Test as soon as possible after corrective work is completed.

E. Acceptance Criteria

1. For the conditions, sequences and modes tested, the system, integral components, and related equipment respond to varying loads and changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

END OF REQUIREMENTS FOR NURSE CALL SYSTEM TEST

3.17 ACCESS CONTROL SYSTEM FPT:

A. Parties Responsible to Execute Functional Test
   1. Electrical contractor
   2. CxA: to witness, direct and document testing.
   3. Equipment manufacturer's representative, as required.
   4. Owner's Representative
   5. Owner's maintenance staff, as desired.

B. Prerequisites: The applicable prerequisite checklist items listed in paragraph 3.8.B shall be listed on each certificate of readiness form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the startup plan checklists previously completed by the installer, before the beginning of functional testing.

C. Functions / Modes Required to be Tested
   1. Demonstrate operation of access control system per specifications including the following:
      a. Card reader control of doors through access control system.
      b. Verify tie-in to existing hospital systems.
      c. Verify system function upon loss of power.

D. Results: If specified equipment performance is not achieved, the Contractor shall have corrections made and reschedule Functional Performance Test as soon as possible after corrective work is completed.

E. Acceptance Criteria
   1. For the conditions, sequences and modes tested, the system, integral components, and related equipment respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

END OF REQUIREMENTS FOR ACCESS CONTROL SYSTEM TEST

3.18 FIRE ALARM SYSTEM FPT:

A. Parties Responsible to Execute Functional Test
   1. Electrical contractor
   2. Life Safety Systems contractor
   3. CxA: to witness, direct and document testing.
   4. Equipment manufacturer's representative, as required.
   5. Owner's Representative
   6. Owner's maintenance staff, as desired.

B. Prerequisites: The applicable prerequisite checklist items listed in paragraph 3.7.B shall be listed on each certificate of readiness form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the startup plan checklists previously completed by the installer, before the beginning of functional testing.

C. Functions / Modes Required to be Tested
   1. Demonstrate operation of fire alarm system per specifications including the following:

a. Alarm initiating devices including pull stations, ceiling smoke detectors, duct smoke detectors, heat detectors, and sprinkler alarm switches.
b. Air handling unit redirect upon alarm and alarm reset.
c. Verify tie-in and proper system operation with any off-site system monitoring.
d. Fire alarm system annunciator panel.
e. Alarm devices, visual and audible.

D. Results: If specified equipment performance is not achieved, the Contractor shall have corrections made and reschedule Functional Performance Test as soon as possible after corrective work is completed.

E. Acceptance Criteria
1. For the conditions, sequences and modes tested, the system, integral components, and related equipment respond to varying loads and changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

END OF REQUIREMENTS FOR FIRE ALARM SYSTEM TEST

END OF SECTION 26 08 00

SECTION 26 09 23 - LIGHTING CONTROL EQUIPMENT

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. Types of lighting control equipment specified in this SECTION include the following:
   1. Time controlled switches.
   2. Photo sensor controls.
   3. Standalone daylight-harvesting switching controls.
   4. Indoor occupancy sensors.
   5. Outdoor motion sensors.
   6. Lighting Contactors.
   7. Emergency shunt relays.

1.03 RELATED REQUIREMENTS:

A. DIVISION 26 Sections for wires/cables, electrical boxes, fittings, and wiring devices which are required in conjunction with lighting control equipment work.

B. SECTION 26 27 26 - WIRING DEVICES.

1.04 REFERENCE STANDARDS:

A. Applicable Standards: Comply with applicable requirements of following standards.
   1. Electronic Industries Association (EIA):
      a. RS-232 - Interface between data terminal and equipment data communication equipment employing serial binary data interchange.
      b. RS-453 - Dimensional, Mechanical, and Electrical Characteristics Defining Phone Plugs and Jacks.
   2. National Electrical Manufacturers' Association (NEMA):
      a. Pub. No. 250 - Enclosures for Electrical Equipment (1,000V Maximum).
   3. National Fire Protection Association (NFPA):
      a. 70 - National Electrical Code (NEC): Comply with applicable local electrical code requirements of the authority having jurisdiction and NEC as applicable to construction and installation of lighting control and communications equipment.
   4. Underwriters Laboratories (UL): Provide lighting control equipment and components which are UL-listed and labeled.
      a. 486A - Wire Connectors and Soldering Lugs for Use with Copper Conductors.

1.05 SUBMITTALS:

A. Refer to DIVISION 01 for administrative and procedural requirements for submittals.

B. Includes, but not limited to, the following:
   1. Product Data: Submit manufacturer's data on lighting control equipment and components.
   2. For modular dimming controls; include elevation, dimensions, features, characteristics, ratings, and labels.
   3. Device plates and plate color and material.
   4. LED driver and lamp combinations compatible with dimmers.
   5. Wiring Diagrams: Power, signal, and control wiring.

6. Shop Drawings: Submit dimensioned drawings of lighting control equipment and components including, but not necessarily limited to, programmable controllers, transceivers, printers, relays, sensors, contactors, and switches. Provide floor plans that clearly identify each controlled zone, including the address code of each zone.
7. Wiring Diagrams: Submit wiring diagrams for lighting control equipment and components showing control wiring and interconnection wiring, including connections to equipment components and electrical power. Differentiate between portions of wiring that are manufacturer factory installed and portions that are field installed.
8. Agreement to Maintain: Prior to time of final acceptance, the Contractor shall submit four copies of an agreement for continued service and maintenance of lighting control equipment for Owner's possible acceptance. Offer terms and conditions for furnishing parts and providing continued testing and servicing, including replacement of materials and equipment, for a one year period with an option for renewal of the Agreement by the Owner.
9. Operation and Maintenance Manuals: Furnish maintenance manuals which contain equipment cuts, operating instructions, shop drawings, wiring diagrams, troubleshooting procedures, and spare parts list for equipment. Ensure that the manual includes operating instructions in addition to instructions for revising the system's software package.

1.06 DELIVERY, STORAGE, AND HANDLING:

A. Deliver lighting control equipment and components in factory-fabricated type containers or wrappings that properly protect equipment from damage.
B. Store lighting control equipment in original packaging and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping.
C. Handle lighting control equipment carefully to prevent physical damage to equipment and components. Do not install damaged equipment; remove from site and replace damaged equipment with new.

1.07 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.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Subject to compliance with requirements, provide lighting control equipment of one of the following (for each type of equipment):
1. Cutler-Hammer.
2. Eaton Corporation.
3. Leviton Manufacturing Company, Inc.
4. Lutron Electronics, Inc.
5. Sensor Switch, Inc.Square D Co.; a brand of Schneider Electric.
6. Watt Stopper.

2.02 OUTDOOR PHOTOELECTRIC SWITCHES:

A. Description: Solid state, with DPST dry contacts rated for 4000VA, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lux), with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.
   3. Time Delay: Fifteen second minimum, to prevent false operation.
   4. Surge Protection: Metal-oxide varistor.
   5. Mounting: Twist lock complies with NEMA C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.03 DAYLIGHT-HARVESTING SWITCHING CONTROLS:

A. Ceiling-Mounted Switching Controls: Solid-state, light-level sensor unit, with separate power pack, to detect changes in indoor lighting levels that are perceived by the eye.

B. Electrical Components, Devices, and Accessories:
   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 120ºF (0 to 49ºC).
   3. Sensor Output: Contacts rated to operate the associated power pack, complying with UL 773A. Sensor is powered by the power pack.
   4. Power Pack: Dry contacts rated for 20A LED driver load at 120- and 277Vac, Sensor has 24Vdc, 150-mA, Class 2 power source, as defined by NFPA 70.
   5. General Space Sensors Light-Level Monitoring Range: 10 to 200 fc (108 to 2152 lux), with an adjustment for turn-on and turn-off levels within that range.
   6. Atrium Space Sensors Light-Level Monitoring Range: 100 to 1,000 fc (1080 to 10 800 lux), with an adjustment for turn-on and turn-off levels within that range.
   7. Skylight Sensors Light-Level Monitoring Range: 1,000 to 10,000 fc (10 800 to 108 000 lux), with an adjustment for turn-on and turn-off levels within that range.
   8. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling.
   9. Set-Point Adjustment: Equip with deadband adjustment of 25, 50, and 75% above the "on" set point, or provide with separate adjustable "on: and "off" set points.
   10. Test Mode: User selectable, overriding programmed time delay to allow settings check.
   11. Control Load Status: User selectable to confirm that load wiring is correct.
   12. Indicator: Two digital displays to indicate the beginning of on-off cycles.

2.04 DAYLIGHT-HARVESTING DIMMING CONTROLS:

A. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.
   1. Lighting control set point is based on two lighting conditions:
      a. When no daylight is present (target level).
      b. When significant daylight is present.
   2. System programming is done with two hand-held, remote-control tools.
      a. Initial setup tool.
      b. Tool for occupants to adjust the target levels by increasing the set point up to 25%, or by minimizing the electric lighting level.

B. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with separate controller unit, to detect changes in lighting levels that are perceived by the eye.
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Sensor Output: 0 to 10Vdc to operate electronic dimming ballasts. Sensor is powered by controller unit.
   3. Power Pack: Sensor has 24Vdc, Class 2 power source, as defined by NFPA 70.
   4. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc (120 to 640 lux).

2.05 INDOOR OCCUPANCY SENSORS:

A. 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 15 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 277Vac, for 13-A tungsten at 120Vac, and for 1 hp at 120Vac. Sensor has 24Vdc, 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.

B. PIR Type: Ceiling mounted; detect occupants in coverage area by their heat and movement.
   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 sq. inches (232 sq. cm).
   2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1,000 sq. ft. (93 sq. m) when mounted on a 96 inch- (2440 mm-) high ceiling.
   3. Detection Coverage (Corridor): Detect occupancy within 90 feet (27.4 m) when mounted on a 10 foot- (3 m-) high ceiling.

C. Ultrasonic Type: Ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy .
   1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
   2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. (56 sq. m) when mounted on a 96 inch- (2440 mm-) high ceiling.

3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1,000 sq. ft. (93 sq. m) when mounted on a 96 inch- (2440 mm-) high ceiling.
4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2,000 sq. ft. (186 sq. m) when mounted on a 96 inch- (2440 mm-) high ceiling.
5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet (27.4 m) when mounted on a 10 foot- (3 m-) high ceiling in a corridor not wider than 14 feet (4.3 m).

D. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6 inch- (150 mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. inches (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1,000 sq. ft. (93 sq. m) when mounted on a 96 inch- (2440 mm-) high ceiling.

2.06 SWITCHBOX-MOUNTED OCCUPANCY SENSORS:

A. 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 120ºF (0 to 49ºC).
3. Switch Rating: 3000VA LED.

B. Wall-Switch Sensor Tag WS1:
1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft. (84 sq. m).
2. Sensing Technology: PIR.
3. Switch Type: SP, manual "on," automatic "off.
4. Voltage: Dual voltage, 120 and 277V; passive-infrared type.
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 at up to 30 minutes.
7. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

C. Wall-Switch Sensor Tag WS2:
1. Standard Range: 210-degree field of view, with a minimum coverage area of 900 sq. ft. (84 sq. m).
2. Sensing Technology: PIR.
3. Switch Type: SP, manual "on," automatic "off
4. Voltage: Dual voltage, 120 and 277V; passive-infrared type.
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 at up to 30 minutes.
7. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

2.07 EMERGENCY SHUNT RELAY:

A. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.
   1. Coil Rating: 277V.

2.08 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 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES.
B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18AWG. Comply with requirements in SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES.
C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES.

2.09 GENERAL DIMMING DEVICE REQUIREMENTS:

A. Compatibility: Dimming control components shall be compatible with other elements of lighting fixtures, ballasts, transformers, and lighting controls.
B. Dimmers and Dimmer Modules: Comply with UL 508.
   1. Audible Noise and Radio-Frequency Interference Suppression: Solid-state dimmers shall operate smoothly over their operating ranges without audible lamp or dimmer noise or radio-frequency interference. Modules shall include integral or external filters to suppress audible noise and radio-frequency interference.
   2. Dimmer or Dimmer-Module Rating: Not less than 125% of connected load unless otherwise indicated.

2.10 MANUAL MODULAR MULTISCENE DIMMING CONTROLS:

A. Description: Factory-fabricated equipment providing manual modular dimming control consisting of a wall-box-mounted, master-scene controller and indicated number of wall-box zone stations. Controls and dimmers shall be integrated for mounting in one-, two-, or three-gang wall box under a single wall plate. Each zone station shall be adjustable to indicated number of scenes, which shall be recorded on the zone controller.
B. Operation: Automatically change variable dimmer settings of indicated number of zones simultaneously from one preset scene to another when a push button is operated.
C. Each manual modular multiscene dimming controller shall include a master control and remote controls.
D. Each zone shall be configurable to control the following:
   1. LED Lighting
E. Memory: Retain preset scenes through power failures for at least seven days.
F. Device Plates: Style, material, and color shall comply with DIVISION 26, SECTION "WIRING DEVICES."
G. Master-Scene Controller: Suitable for mounting in a single flush wall box.

1. Switches: Master off, group dim, group bright, and selectors for each scene.
2. LED indicator lights, one associated with each scene switch, and one for the master off switch.

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% coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.02 CONTACTOR INSTALLATION:

A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.03 WIRING INSTALLATION:

A. Wiring Method: Comply with SECTION 26 05 19 - 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.

3.04 GROUNDING:

A. Provide equipment ground connections for lighting control equipment. Tighten connectors to comply with tightening torques specified in UL 486A to assure permanent and effective grounding.

3.05 IDENTIFICATION:

A. Provide equipment grounding connections for lighting control equipment. Tighten connectors to comply with tightening torques specified in UL 486A to assure permanent and effective grounding.

B. Identify components and power and control wiring according to SECTION 26 05 53 - 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.
   3. Match campus standards for device labeling.

C. Label time switches and contactors with a unique designation.

D. Label each dimmer module with a unique designation.

E. Label each scene control button with approved scene description.

3.06 FIELD QUALITY CONTROL:

A. Owner will commission lighting controls.
B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
    1. Continuity tests of circuits.
    2. Operational Test: Set and operate controls to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.
        a. Include testing of modular dimming control equipment under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.
    3. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
    4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
D. Lighting control devices will be considered defective if they do not pass tests and inspections.
E. Remove and replace malfunctioning modular dimming control components and retest as specified above.
F. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.
G. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

3.07 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. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.08 DEMONSTRATION:

A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control systems specified in SECTION 26 09 43 - RELAY-BASED LIGHTING CONTROLS.
B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

3.09 PERSONNEL TRAINING:

A. Building Operational Personnel on-site Training: Train Owner's building operating personnel on-site in procedures for starting-up, testing, operating, trouble shooting, servicing and preventive maintenance of the lighting control system equipment for a minimum period of eight hours.

END OF SECTION 26 09 23

SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification SECTIONS, apply to this SECTION.

1.02 SUMMARY:

A. SECTION Includes:
   1. Receptacles, receptacles with integral GFCI, and associated device plates.
   2. Hospital-grade receptacles.
   3. Snap switches and wall-box dimmers.
   4. Wall-switch.
   5. Tamper proof receptacles.

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.

1.04 REQUIREMENTS:

A. Coordination:
   1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
   2. Cord and Plug Sets: Match equipment requirements.

1.05 REFERENCE STANDARDS:

A. National Electrical Manufacturers Association (NEMA):
   1. FB-11-83: Plugs, Receptacles and Connectors of the Pin and Sleeve Type for Hazardous Locations.
   2. PR 2-86: Enclosures for Plugs, Receptacles and Connectors of the Pin and Sleeve Type.
   3. PR 3-86: Guide to Pin and Sleeve Plugs, Receptacles, and Connectors.
   4. WD-1: General Requirement for Wiring Devices.
   5. WD-2: Wiring Devices - Dimensional Requirements.
B. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code (NEC).
C. Underwriters Laboratories (UL):
   1. 20 - General Use Snap Switches.
   2. 498 - Electrical Attachment Plugs and Receptacles.
   3. 544 - Electrical Medical and Dental Equipment.
   4. 943 - Ground-Fault Circuit Interrupters.
   5. 1010 - Receptacle-Plug Combinations for use in Hazardous (Classified) Locations.
   6. 486A-486B - Wire Connectors.

1.06 SUBMITTALS:

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
   2. Leviton Mfg. Company Inc. (Leviton).
   3. Pass & Seymour/Legrand (Pass & Seymour).

B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.02 GENERAL WIRING-DEVICE REQUIREMENTS:

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. Comply with NFPA 70.
C. Receptacles connected to normal power shall match the existing facility standards.
D. Receptacles connected to emergency power shall be red in color.
E. Quick connect devices are not acceptable.

2.03 STRAIGHT-BLADE RECEPTACLES:

A. Hospital-Grade, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596.
   1. Description: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap. Nylon body.

2.04 GFCI RECEPTACLES:

A. General Description:
   1. Straight blade, non-feed-through type.
   2. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
   3. Provide GFCI receptacle capable of self-testing.
B. Hospital-Grade, Duplex GFCI Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, UL 943 Class A, and FS W-C-596.

2.05 TOGGLE SWITCHES:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
   2. Leviton Mfg. Company Inc. (Leviton).
   3. Pass & Seymour/Legrand (Pass & Seymour).
B. Comply with NEMA WD 1, UL 20, and FS W-S-896.
C. Heavy duty grade, quiet type.
D. Switches, 120/277 V, 20 A:
   1. Single Pole.
   2. Two Pole.
   3. Three Way.
   4. Four Way.

2.06 WALL PLATES:

A. Single and combination types shall match corresponding wiring devices.
   1. Plate-Securing Screws: Metal with head color to match plate finish.
   2. Material for Finished Spaces: Ivory plastic .
   3. Material for Unfinished Spaces: Ivory plastic.
   4. Material for C-Section and 7th Floor Procedure Room Locations: Smooth, brushed stainless steel.
   5. Devices on Emergency Power: Red with circuiting information engraved in white on face of wall plate.

   Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, gasketed lift type, designed for wet location protection whether the attachment plug is inserted or removed.

B. All wall plates to identify circuit serving the wiring device.

2.07 FINISHES:

A. Device Color:
   1. Wiring Devices Connected to Normal Power System: White unless otherwise indicated or required by NFPA 70 or device listing.
   2. Wiring Devices Connected to Emergency Power System: Red.
B. Wall Plate Material: Smooth, brushed stainless steel

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
B. Coordination with Other Trades:
   1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
   2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
   3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
   4. Install wiring devices after all wall preparation, including painting, is complete.
C. Conductors:
   1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
   2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
   3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
D. Device Installation:
   1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
   2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.

3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When branch circuit conductors are larger than recommended by device manufacturer for termination, the use of splice pigtails is allowed.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:
1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the left.
2. Install hospital-grade receptacles in all areas with the ground pin or neutral blade at the top.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

3.02 GFCI RECEPTACLES:

A. Install non-feed-through-type GFCI receptacles for locations within 6 feet of sinks and as indicated on drawings.

3.03 IDENTIFICATION:

A. Comply with SECTION 26 05 53 – ELECTRICAL IDENTIFICATION.

B. Identify each receptacle and light switch wall plate with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face or plate for devices connected to normal power and red-filled lettering on face of plate for devices connected to emergency power with brushed stainless wall plate, and durable wire markers or tags inside outlet boxes.

3.04 FIELD QUALITY CONTROL:

A. Test wiring devices for proper polarity, ground continuity, and compliance with requirements.

B. Test GFCI operation with device mounted pushbutton.

C. Wiring device will be considered defective if it does not pass tests and inspections.

END OF SECTION 26 27 26

SECTION 26 28 13 – 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. This SECTION specifies fuse work as indicated by Drawings and by requirements of this SECTION. Types of fuses specified in this SECTION include the following:
   1. Class J current-limiting.
   2. Class L current-limiting and time-delay.
   3. Class L current-limiting and fast-acting.
   4. Class RK1 current-limiting and time-delay.
   5. Class RK1 and Class J current-limiting.
   6. Class RK5 current-limiting and time-delay.
   7. Cable Limiters.

1.03 RELATED REQUIREMENTS:

A. SECTION 26 05 73 - OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY.
B. SECTION 26 23 00 - LOW-VOLTAGE SWITCHGEAR.
C. SECTION 26 24 16 - PANELBOARDS.
D. SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS.

1.04 REFERENCE STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
B. Applicable Standards: Comply with applicable requirements of following standards.
   1. American National Standards Institute (ANSI):
      a. C97.1 - Low-Voltage Cartridge Fuses 600V or Less.
   2. National Electrical Manufacturer's Association (NEMA):
      a. FU1 - Low-Voltage Cartridge Fuses.
   3. National Fire Protection Association (NFPA):
      a. 70 - National Electrical Code (NEC). Comply with NEC as applicable to construction and installation of fusible devices.
   4. Underwriters Laboratories (UL): Provide overcurrent protective devices which are UL-listed and labeled.
      a. 248-1 - Low-Voltage Fuses - Part 1: General Requirements.
      b. 248-8 - Low-Voltage Fuses - Part 8: Class J Fuses.
      c. 248-10 - Low-Voltage Fuses - Part 10: Class L Fuses.
      d. 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses.

1.05 SUBMITTALS:

A. Refer to DIVISION 01 for administrative and procedural requirements for Submittals.
B. Includes, but not limited to, the following:
   1. Product Data: Submit manufacturer's technical product data on fuses, including specifications, electrical characteristics, and time current curves.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Subject to compliance with requirements, provide fuses of one of the following:
   1. Eaton's Bussmann Business, Inc.
   2. Mersen.
   3. Littelfuse, Inc.

2.02 FUSES:

A. General: Except as otherwise indicated, provide fuses of types, sizes, ratings, and average melting-time-current and peak let-through current characteristics which comply with manufacturer's standard design and materials, are constructed in accordance with published product information, and constructed with industry standards and configurations.

B. For applications greater than 600A: Class L Current-Limiting and Time-Delay Fuses.
   1. UL Class L, time-delay fuses, rated 600V, 60 hertz, amperes as indicated, with 200,000 RMS amperes symmetrical interrupting current rating for protecting transformers, motors, and circuit breakers.

C. For applications greater than 600A: Class L Current-Limiting and Fast-Acting Fuses.
   1. UL Class L, fast-acting fuses, rated 600V, 60 hertz, amperes as indicated, with 200,000 RMS amperes symmetrical interrupting current rating for protecting service entrances and feeder circuit breakers.

D. For applications less than or equal to 600A: Class RK1 Current-Limiting and Time-Delay Fuses.
   1. UL Class RK1 time-delay fuses rated 250 or 600V (voltage rating as required), 60 hertz, amperes as indicated, with 200,000 RMS amperes symmetrical interrupting current rating for protecting motors, transformers, and circuit breakers.

E. For applications less than or equal to 600A: Class RK1 Current-Limiting and Fast-Acting Fuses.
   1. UL Class RK1 current-limiting fuses rated 250 or 600V (voltage rating as required), 60 hertz, amperes as indicated, with 200,000 RMS amperes symmetrical interrupting current rating for protecting service entrances and feeder circuit breakers.

F. For applications less than or equal to 600A: Class J Fast-Acting Current-Limiting Fuses.
   1. UL Class J current-limiting fuses rated 600V, 60 hertz, amperes as indicated with 200,000 RMS amperes symmetrical interrupting current rating.

G. For applications less than or equal to 600A: Class RK5 Current-Limiting and Time-Delay Fuses.
   1. UL Class RK5 time-delay fuses rated 250 or 600V (voltage rating as required), 60 hertz, amperes as indicated, with 200,000 RMS amperes symmetrical interrupting current rating for protecting motors.

2.03 ACCESSORIES:

A. Clip-clamps sized for fuse clip and manufactured by the fuse manufacturer.

B. Fuse reducers manufactured by the fuse manufacturer.

2.04 SPARE FUSES:

A. Maintenance Stock Fuses: For types and ratings required, furnish additional fuses, amounting to two units for every ten installed units, but not less than one set of three of each type and rating.

B. Provide one wall-mounted, gray enamel, 18-gage steel spare fuse cabinet for each room containing a switchboard, switchgear, panelboard, or motor control center that utilizes fused devices. Cabinet shall be large enough to contain 20% of the fuses used in that room. The words "SPARE FUSES" shall be stenciled in 1-1/2-inch high black letters on the door.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine areas and conditions under which fuses are to be installed. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF FUSES:

A. Install fuses as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to ensure that protective devices comply with requirements. Comply with NEC and NEMA standards for installation of fuses.
B. Fuses shall not be installed until equipment is ready to be energized.
C. Install fuses in fused switches.
D. All fuses in each switch (or circuit breaker) shall be the same rating, same type, and from the same manufacturer.
E. Install fuses in disconnect switches as required to provide protection as indicated on packaged HVAC equipment nameplates. Fuse sizes indicated on Drawings are approximate. Install fuse size as indicated on packaged HVAC equipment nameplates.
F. Install fuse clip-clamps on all fuses which are mounted on mechanical equipment subject to vibration.
G. Install fuse reducers as required.
H. Install fuse cabinets on wall adjacent to fused equipment; coordinate location with all building trades. Stock all spare fuses in fuse cabinets in proportion to their use in that room.
I. Provide typewritten label on the inside of the door of each fused switch indicating replacement fuse type, class and ampere rating.

3.03 FIELD QUALITY CONTROL:

A. Prior to energization of fusible devices, test fuses and fused switches for continuity and for short-circuits. Replace malfunctioning units with new units, and then demonstrate compliance with requirements.

END OF SECTION 26 28 13

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26 28 16 - CIRCUIT AND MOTOR DISCONNECT 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 switches.
   2. Nonfusible switches.
   3. Enclosures.

1.03 RELATED REQUIREMENTS:

A. SECTION 26 05 53 - ELECTRICAL IDENTIFICATION.
B. SECTION 26 27 26 - WIRING DEVICES for manual switches used as motor disconnects.
C. SECTION 26 28 13 - FUSES.

1.04 REFERENCE STANDARDS:

A. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000V maximum).
   2. KS 1 - Enclosed Switches.
B. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code (NEC).
C. Underwriters Laboratories (UL):
   1. 98 - Enclosed and Dead-Front Switches.
   2. 869 - Electrical Service Equipment.
   3. 894 - Switches for Use in Hazardous (Classified) Locations.
   4. 977 - Fused Power-Circuit Devices.

1.05 DEFINITIONS:

A. NC: Normally closed.
B. NO: Normally open.
C. SPDT: Single pole, double throw.

1.06 SUBMITTALS:

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
   1. Enclosure types and details for types other than NEMA 250, Type 1.
   2. Current and voltage ratings.
   3. Short-circuit current ratings (interrupting and withstand, as appropriate).
   4. Include evidence of U.L. listing for series rating of installed devices.
   5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
   6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.07 QUALITY ASSURANCE:

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NFPA 70.

1.08 PROJECT CONDITIONS:

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22ºF and not exceeding 104ºF.
2. Altitude: Not exceeding 6600 feet.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Engineer and Owner no fewer than seven days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without Engineer's and Owner's written permission.
4. Comply with NFPA 70E.

C. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.09 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 FUSIBLE AND NONFUSIBLE SWITCHES:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper ground conductors.
   a. Provide where ground conductors are indicated in the circuit.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper neutral conductors.
   a. Provide where neutral conductors are indicated in the circuit.
3. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), 120 V, 15 A rating, arranged to activate before switch blades open.
   a. Where installed between variable frequency drives and motors, provide electrical interlock kits to break the control circuit before the main switch blades open.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: Mechanical type, suitable for number, size, and conductor material.
7. Service-Rated Switches: Labeled for use as service equipment.
8. Accessory Control Power Voltage: Remote mounted and powered; 120-Vac.

D. Nonfusible type for motor loads 1 hp or smaller or nonmotor loads connected to a 20 A or smaller circuit may be toggle type switches, UL listed for each specific type load.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
   b. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
   c. Leviton Mfg. Company Inc. (Leviton).
   d. Pass & Seymour/Legrand (Pass & Seymour).

2.02 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Square D; a brand of Schneider Electric.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. 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.

D. Features and Accessories:
1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
6. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

7. Electrical Operator: Provide remote control for on, off, and reset operations.
8. Accessory Control Power Voltage: Integrally mounted, self-powered; 120-V ac.

2.03 MOLDED-CASE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Square D; a brand of Schneider Electric.

B. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

C. Features and Accessories:
   1. Standard frame sizes and number of poles.
   2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
   3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
   4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
   5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
   6. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic switch contacts, "b" contacts operate in reverse of switch contacts.
   7. Electrical Operator: Provide remote control for on, off, and reset operations.
   8. Accessory Control Power Voltage: Integrally mounted, self-powered; 120-V ac.

2.04 ENCLOSURES:

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
   1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
   2. Outdoor Locations: NEMA 250, Type 3R.
   3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.

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 individual wall-mounted switches with tops at uniform height unless otherwise indicated.

B. Comply with mounting and anchoring requirements specified in SECTION 26 05 29 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS and SECTION 26 05 48 - SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS.

C. Disconnects shall be installed where specified herein, indicated on the Drawings, or required by manufacturer's written instructions.

D. Install combination disconnect/motor starters furnished under other Divisions.
E. Provide control wiring for electrical interlocks between drives and variable frequency motor disconnect switches.
F. Coordinate disconnect installation with raceways, wiring, and equipment.

3.03 LOCATION:
A. Coordinate location of disconnects with equipment being controlled.
B. When used as disconnecting means, locate as near as practicable to the load controlled.
C. Disconnects provided integral with equipment shall serve as disconnecting means where allowed by NFPA 70.
D. When used for branch circuit protection, disconnects shall be located as near as practicable to the supply end of the conductors being protected.
E. Disconnects used with motor-driven appliances, or motors and controllers shall be located within sight of controller, unless indicated otherwise on the Drawings.
F. Disconnects shall be installed in accessible locations.

3.04 FUSIBLE DISCONNECTS:
A. Fusible disconnects shall not be mounted in ceiling plenums.
B. Fuses shall be installed in fusible disconnects as specified in SECTION 26 28 13 - FUSES.

3.05 IDENTIFICATION:
A. Comply with requirements in SECTION 26 05 53 – ELECTRICAL IDENTIFICATION.
1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved laminated-plastic nameplate.

3.06 ADJUSTING:
A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
B. Set field-adjustable circuit-breaker trip ranges as specified in SECTION 26 05 73 - OVERCURRENT PROTECTIVE DEVICE STUDIES.

END OF SECTION 26 28 16

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SECTION 26 29 23 – VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this SECTION.

1.02 SUMMARY:

A. This SECTION includes separately enclosed, pre-assembled, combination VFCs, rated 600V and less, for speed control of three-phase, squirrel-cage induction motors.

1.03 RELATED REQUIREMENTS:

A. SECTION 26 24 19 - MOTOR-CONTROL CENTERS FOR VFCS installed in motor-control centers.

1.04 REFERENCE STANDARDS:

A. Applicable Standards: (Comply with applicable requirements of the following standards).
   1. National Electrical Manufacturers Association (NEMA):
      a. 250 - Enclosures for Electrical Equipment (1,000V Maximum).
      b. ICS 1 - Standard for Industrial Control and Systems: General Requirements.
      c. [ICS 3.1 - Guide for the Application, Handling, Storage, Installation and Maintenance of Medium-Voltage AC Contactors, Controllers and Control Centers.]
      d. ICS 6 - Enclosures.
      e. ICS 7 - Adjustable Speed Drives.
      f. [ICS 7.1 - Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems].
      g. [ICS 61800-1 - Adjustable Speed Electrical Power Drive Systems, Part 1: General Requirements-Rating Specifications for Low Voltage Adjustable-Speed DC Power Drive Systems].
      h. [ICS 61800-2 - Adjustable Speed Electrical Power Drive Systems, Part 2: General Requirements-Rating Specifications for Low Voltage Adjustable Frequency AC Power Drive Systems].
      i. [ICS 61800-4 - Adjustable Speed Electrical Power Drive Systems, Part 4: General Requirements-Rating Specifications for AC Power Drive Systems Above 1,000Vac and Not Exceeding 35 kV].
      j. ICS 61800-3 - Adjustable speed electrical power drive systems - Part 3: EMC Requirements and Specific Test Methods.
   2. National Fire Protection Association (NFPA):
      a. NFPA 70 - National Electrical Code.
   3. Underwriters Laboratories (UL):
      a. 489 - UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
      b. 508C - UL Standard for Safety Power Conversion Equipment.
      c. [1995 - UL Standard for Safety Heating and Cooling Equipment].
   4. Institute of Electrical and Electronics Engineers (IEEE):
      a. 519 - Recommended Practices and requirements for Harmonic Control in Electrical Power Systems.

b. 399 - Recommended Practice for Industrial and Commercial Power Systems Analysis (Brown Book).

5. InterNational Electrical Testing Association (NETA):
   a. ANSI/NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.

1.05 SUBMITTALS:

A. Product Data: For each type and rating of VFC indicated. Include features, performance, electrical ratings, operating characteristics, shipping and operating weights, and furnished specialties and accessories.

B. [LEED®: Product Data for Credit EA 5: For continuous metering equipment for energy consumption.]

C. Shop Drawings: For each VFC indicated. Include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment. Enclosure types and details.
   1. Nameplate legends.
   2. Short-circuit current (withstand) rating of enclosed unit.
   3. Features, characteristics, ratings, and factory settings of each VFC and installed devices.
   4. Specified modifications.
   5. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring.

D. Harmonic Analysis Study and Report: Comply with IEEE 399 and NETA Acceptance Testing Specification; identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system.

PART 2 - PRODUCTS

2.01 VARIABLE FREQUENCY MOTOR CONTROLLERS:

A. General Requirements for VFCs: Comply with NEMA ICS 7, [NEMA ICS 61800-1], [NEMA ICS 61800-2], [NEMA ICS 61800-4] and UL 508C.

B. Application: [Constant torque] [variable torque].

C. VFC Description: Variable-frequency power converter (rectifier, dc bus, and IGBT / PWM inverter) factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by UL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
   1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
   2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
   3. Listed and labeled for integrated short-circuit current (withstand) rating.
   4. [UL 1995 Plenum Rated.]

D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

E. Output Rating: Three-phase; 10 to [60 Hz, with voltage proportional to frequency throughout voltage range] [66 Hz, with torque constant as speed changes]; maximum voltage equals input voltage.

F. Unit Operating Requirements:
   1. Input AC Voltage Tolerance: +10% and -15% of VFC input voltage rating.
   2. Input AC Voltage Unbalance: Not exceeding 5%.
   3. Input Frequency Tolerance: ±3% of VFC frequency rating.
   4. Minimum Efficiency: 96% at 60 Hz, full load.
   5. Minimum Displacement Primary-Side Power Factor: 96% under any load or speed condition.
   6. Minimum Short-Circuit Current (Withstand) Rating: [10] [22] [65] [100] KA [as indicated on plans].
   7. Ambient Temperature Rating: Not less than 14ºF (-10ºC) and not exceeding 104ºF (40ºC).
   8. Ambient Storage Temperature Rating: Not less than -4ºF (-20ºC) and not exceeding 140ºF (60ºC).
   9. Humidity Rating: Less than 95% (noncondensing).
   10. Altitude Rating: Not exceeding 3,300 ft. (1,005 m).
   11. Vibration Withstand: Comply with IEC 60068-2-6.
   12. Overload Capability: 1.5 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
   13. Starting Torque: Minimum 100% of rated torque from 3 to 60 Hz.
   14. Speed Regulation: ±5%.
   15. Output Carrier Frequency: [Selectable; 1.5 to 15 kHz.][minimum 5kHz.]
   16. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
   17. Inverter Logic: Microprocessor based, isolated from all power circuits.
   18. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
   19. Internal Adjustability Capabilities:
      a. Minimum Speed: 5 to 25% of maximum rpm.
      b. Maximum Speed: 80 to 100% of maximum rpm.
      c. Acceleration: [0.1 to 999.9] seconds.
      d. Deceleration: [0.1 to 999.9] seconds.
      e. Current Limit: 30 to minimum of 150% of maximum rating.
   20. Self-Protection and Reliability Features:
      a. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10% or more above nominal line voltage.
      b. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
      c. Under- and overvoltage trips.
      d. Inverter overcurrent trips.
      e. VFC and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
      f. Critical frequency rejection, with [three] selectable, adjustable deadbands.
      g. Instantaneous line-to-line and line-to-ground overcurrent trips.
      h. Loss-of-phase protection.
      i. Reverse-phase protection.
      j. Short-circuit protection.
      k. Motor overtemperature fault.

21. [Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.]
22. [Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.]
23. [Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.]
24. [Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.]
25. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

G. Integral Input Disconnecting Means and OCPD: UL 489, thermal-magnetic circuit breaker with pad-lockable, door-mounted handle mechanism.
1. Disconnect Rating: Not less than 115% of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
2. Auxiliary Contacts: NO/NC, arranged to activate before disconnect opens.

2.02 CONTROLS AND INDICATION:

A. Status Lights: Door-mounted LED indicators displaying the following conditions:
1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
3. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.

C. Historical Logging Information and Displays:
1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last [four] <Insert number> faults with time and date stamp for each.

D. Indicating Devices: Digital display mounted flush in VFC door and connected to display VFC parameters including, but not limited to:
1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).

4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (Vdc).
9. Set point frequency (Hz).
10. Motor output voltage (Vac).

E. Control Signal Interfaces:
1. Electric Input Signal Interface:
a. A minimum of [two] programmable analog inputs: [0- to 10Vdc] [4- to 20-mA dc].
b. A minimum of [six] multifunction programmable digital inputs.
c. Pneumatic Input Signal Interface: 3 to 15 psig (20 to 104 kPa).
d. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems.
e. Potentiometer using up/down digital inputs.
f. Fixed frequencies using digital inputs.

F. Output Signal Interface: A minimum of [one] programmable analog output signal(s) ([0 to 10Vdc] [4- to 20-mA dc], which can be configured for any of the following:
1. Output frequency (Hz).
2. Output current (load).
3. DC-link voltage (Vdc).
4. Motor torque (percent).
5. Motor speed (rpm).
6. Set point frequency (Hz).

G. Remote Indication Interface: A minimum of [two] programmable dry-circuit relay outputs (120Vac, 1 A) for remote indication of the following:
1. Motor running.
2. Set point speed reached.
3. Fault and warning indication (overtemperature or overcurrent).
4. PID high- or low-speed limits reached.

H. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.

I. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display VFC status and alarms[and energy usage]. Allows VFC to be used with an external system within a multidrop LAN configuration; settings retained within VFC's nonvolatile memory.
1. Network Communications Ports: Ethernet and [RS-422/485].
2. Embedded BAS Protocols for Network Communications: [ASHRAE 135 BACnet] [Echelon LonWorks] [Johnson Metasys N2] [Modbus/Memobus] [Siemens System 600 APOGEE] [DeviceNet] [ProfiBus DP] [CANopen] [SmartWire] protocols accessible via the communications ports.

2.03 LINE CONDITIONING AND FILTERING:

A. Input Line Conditioning: Based on the harmonic analysis study and report, provide input filtering, as required, to limit TDD at input terminals of [indicated] VFCs to less than 5% and THD(V) to 3%.

B. EMI/RFI Filtering: CE marked; certify compliance with NEMA ICS 61800-3 for Category C2.

2.04 [MAINTENANCE BYPASS SYSTEMS:]

A. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.

B. [Bypass Mode: Manual operation only; requires local operator selection at VFC. Transfer between power converter and bypass contactor and retransfer shall only be allowed with the motor at zero speed].

C. [Bypass Mode: Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic control system feedback].

D. [Bypass Controller: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller[; with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and deenergized, while motor is operating in bypass mode].
   1. Bypass Contactor: Load-break, NEMA-rated contactor.
   2. Output Isolating Contactor: Non-load-break, NEMA-rated contactor.
   3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism].

E. [Bypass Controller: Three-contactor-style bypass allows motor operation via the power converter or the bypass controller[; with input isolating switch and barrier] arranged to isolate the power converter input and output and permit safe testing[and troubleshooting] of the power converter, both energized and de-energized, while motor is operating in bypass mode.
   1. Bypass Contactor: Load-break, NEMA-rated contactor.
   2. Input and Output Isolating Contactors: Non-load-break, NEMA-rated contactors.
   3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism].

F. Bypass Contactor Configuration: [Full-voltage (across-the-line)] [Reduced-voltage (autotransformer)] type.
   1. NORMAL/BYPASS selector switch.
   2. HAND/OFF/AUTO selector switch.
   3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.

G. Overload Relays: NEMA ICS 2.

2.05 ENCLOSURES:

A. VFC Enclosures: NEMA 250, Type 1, [Type 3R], [Type 4X], [as indicated on plans] or equivalent IEC IP Type.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, [insert Project-specific conditions,] and other conditions affecting performance.

B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.
C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:

A. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
B. Wall-Mounting Controllers: Install VFCs on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches (2,000 mm) above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS.
C. Floor-Mounted Controllers: Install VFCs on 4 inch (100 mm) nominal thickness concrete base. Comply with requirements for concrete base specified in SECTION 03 30 00 - CAST-IN-PLACE CONCRETE.
    1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18 inch (450 mm) centers around the full perimeter of concrete base.
    2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
    3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
    4. Install anchor bolts to elevations required for proper attachment to supported equipment.

3.03 CONTROL WIRING INSTALLATION:

A. Install wiring between VFCs and remote devices[and facility's central-control system]. Comply with requirements in SECTION 26 05 23 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES.
B. Bundle, train, and support wiring in enclosures.
C. Connect selector switches and other automatic control devices where applicable.
    1. Connect selector switches to bypass only those manual- and automatic control devices that have no safety functions when switches are in manual-control position.
    2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.04 FIELD QUALITY CONTROL:

A. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
B. Test continuity of each circuit.
C. Tests and Inspections:
    1. Inspect VFC, wiring, components, connections, and equipment installation.
    2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
    3. Verify that voltages at VFC locations are within 10% of motor nameplate rated voltages.
    4. Test each motor for proper phase rotation.

5. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

D. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

E. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

F. VFCs will be considered defective if they do not pass tests and inspections.

END OF SECTION 26 29 23

SECTION 26 33 23 - CENTRAL BATTERY EQUIPMENT

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 UPS central battery inverters with the following features:
   1. Output distribution section.
   2. Internal maintenance bypass/isolation switch.
   3. External maintenance bypass/isolation switch.
   4. Emergency-only circuits.
   5. Remote monitoring provisions.

1.03 RELATED REQUIREMENTS:

A. SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES.
B. SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
C. SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS for construction of concrete base.
D. SECTION 26 05 33 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS.
E. SECTION 26 05 48 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS.
F. SECTION 26 24 16 - PANEL BOARDS.
G. SECTION 26 43 13 - SURGE PROTECTION DEVICES.

1.04 REFERENCE STANDARDS:

A. National Fire Protection Association (NFPA):
   1. NFPA 70 - National Electrical Code.
   2. NFPA 101 - Life Safety Code.
B. Underwriters Laboratories (UL):
   1. UL 924 - Standard for Emergency Lighting and Power Equipment.

1.05 DEFINITIONS:

A. LCD: Liquid-crystal display.
B. LED: Light-emitting diode.
C. THD: Total harmonic distortion.
D. UPS: Uninterruptible power supply.

1.06 SUBMITTALS:

A. Product Data: For the following:
   1. Electrical ratings, including the following:
      a. Capacity to provide power during failure of normal ac.
      b. Inverter voltage regulation and THD of output current.
      c. Rectifier data.
      d. Transfer time of transfer switch.
      e. Data for specified optional features.

2. Transfer switch.
3. Inverter.
4. Battery charger.
5. Batteries.
6. Battery monitoring.
7. Battery-cycle warranty monitor.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, components, and location and identification of each field connection. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.
1. Wiring Diagrams: Detail internal and interconnecting wiring; and power, signal, and control wiring.
2. Elevation and details of control and indication displays.
3. Output distribution section.

C. Qualification Data: For testing agency.

D. Manufacturer Seismic Qualification Certification: Submit certification that central battery inverter equipment will withstand seismic forces defined in SECTION 26 05 48 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS. Include the following:
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
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. Source quality-control test reports.

F. Field quality-control test reports.

G. Warranty: Special warranty specified in this SECTION.

H. Operation and Maintenance Data: For central battery inverter equipment to include in emergency, operation, and maintenance manuals.

I. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Owner.
1. Fuses: One for every 10 of each type and rating, but no fewer than <Insert quantity> of each.
2. Cabinet Ventilation Filters: One complete set.
3. One spare circuit board for each critical circuit.

1.07 QUALITY ASSURANCE:

A. Central Battery Inverter System: UL 924 and UL 1778 listed.

B. Comply with NFPA 70 and NFPA 101.

1.08 DELIVERY, STORAGE, AND HANDLING:

A. Deliver equipment in fully enclosed vehicles.

B. Store equipment in spaces having environments controlled within manufacturers' written instructions for ambient temperature and humidity conditions for non-operating equipment.

1.09 WARRANTY:

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace batteries that fail in materials or workmanship within specified warranty period. Special warranty, applying to batteries only, applies to materials only, on a prorated basis, for period specified.

1. Warranty Period: Include the following warranty periods, from date of Substantial Completion:

a. Premium, Valve-Regulated, Recombinant, Lead-Calcium Batteries:

(1) Full Warranty: One year.

(2) Pro Rata: 19 years.

b. Standard, Valve-Regulated, Recombinant, Lead-Calcium Batteries:

(1) Full Warranty: One year.

(2) Pro Rata: Nine years.

c. Nickel-Cadmium, Wet-Cell Batteries:

(1) Full Warranty: Five years.

(2) Pro Rata: 15 years.

d. Lead-Calcium, Wet-Cell Batteries:

(1) Full Warranty: One year.

(2) Pro Rata: Nine years.

e. Lead-Antimony, Wet-Cell Batteries:

(1) Full Warranty: One year.

(2) Pro Rata: Nine years.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

1. Bigbeam Emergency Systems, Inc.; Siltron Division.
2. Cooper Industries, Inc.; Sure-Lites Division.
3. Crucial Power Products.
4. Dual-Lite.
5. Hubbell Incorporated; Hubbell Lighting.
6. Lightguard/Chloride Systems.
7. Lithonia Lighting; Emergency Lighting Systems.
8. Thomas & Betts Corporation; Emergi-Lite Division.
9. Thomas & Betts Corporation; Lightalarms Division.

2.02 INVERTER PERFORMANCE REQUIREMENTS:

A. UPS-Type Central Battery Inverters: Continuously provide ac power to connected electrical system.

1. Automatic Operation:

a. Normal Conditions: Supply the load with ac power flowing from normal ac power input terminals, through rectifier-charger and inverter, with battery connected in parallel with rectifier-charger output.

b. Abnormal Supply Conditions: If normal ac supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, battery supplies constant, regulated, inverter ac power output to the load without switching or disturbance.
c. If normal power fails, battery continues supply-regulated ac power through the inverter to the load without switching or disturbance.
d. When power is restored at normal supply terminals of system, controls automatically synchronize inverter with the external source before transferring the load. Rectifier-charger then supplies power to the load through the inverter and simultaneously recharges battery.
e. If battery becomes discharged and normal supply is available, rectifier-charger charges battery. When battery is fully charged, rectifier-charger automatically shifts to float-charge mode.
f. If any element of central battery inverter system fails and power is available at normal supply terminals of system, static bypass transfer switch transfers the load to normal ac supply circuit without disturbance or interruption of supply.
g. If a fault occurs in system supplied by central battery inverter and current flows in excess of the overload rating of central battery inverter system, static bypass transfer switch operates to bypass fault current to normal ac supply circuit for fault clearing.
h. When fault has cleared, static bypass transfer switch returns the load to central battery inverter system.
i. If battery is disconnected, central battery inverter continues to supply power to the load with no degradation of its regulation of voltage and frequency of output bus.

2. Manual Operation:
a. Turning inverter off causes static bypass transfer switch to transfer the load directly to normal ac supply circuit without disturbance or interruption.
b. Turning inverter on causes static bypass transfer switch to transfer the load to inverter.

2.03 SERVICE CONDITIONS:

A. Environmental Conditions: Inverter system shall be capable of operating continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
1. Ambient Temperature for Electronic Components: 32 to 98ºF (0 to 37ºC).

2.04 INVERTERS:

A. Description: Solid-state type, with the following operational features:
1. Automatically regulate output voltage to within ±5%.
2. Automatically regulate output frequency to within ±1 Hz, from no load to full load at unit power factor over the operating range of battery voltage.
3. Output Voltage Waveform of Unit: Sine wave with maximum 10% THD throughout battery operating-voltage range, from no load to full load.
a. THD may not exceed 5% when serving a resistive load of 100% of unit rating.
4. Output Protection: Current-limiting and short-circuit protection.
5. Output Protection: Ferroresonant transformer to provide inherent overload and short-circuit protection.
6. Surge Protection: Specified in SECTION 26 43 13 - SURGE PROTECTIVE DEVICES (SPD).

7. Overload Capability: 125% for 10 minutes; 150% surge.
8. Brownout Protection: Produces rated power without draining batteries when input voltage is down to 75% of normal.

2.05 BATTERY CHARGER:

A. Description: Solid-state, automatically maintaining batteries in fully charged condition when normal power is available. With LED indicators for "float" and "high-charge" modes.

2.06 BATTERIES:

A. Description: Standard, valve-regulated, recombinant, lead-calcium batteries.
   1. Capable of sustaining full-capacity output of inverter unit for minimum of 90 minutes.

2.07 ENCLOSURES:

A. NEMA 250, Type 1 steel cabinets with access to components through hinged doors with flush tumbler lock and latch.
B. Finish: Manufacturer's standard baked-enamel finish over corrosion-resistant prime treatment.

2.08 SEISMIC REQUIREMENTS:

A. Central battery inverter assemblies, subassemblies, components, fastenings, supports, and mounting and anchorage devices shall be designed and fabricated to withstand seismic forces. The term "withstand" is defined in the "Manufacturer Seismic Qualification Certification" Paragraph in Part 1 "Informational Submittals" Article.

2.09 CONTROL AND INDICATION:

A. Description: Group displays, indications, and basic system controls on common control panel on front of central battery inverter enclosure.
B. Minimum displays, indicating devices, and controls shall include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items. Alarms shall include an audible signal and a visual display.
C. Indications: Plain-language messages on a digital LCD or LED.
   1. Quantitative Indications:
      a. Input voltage, each phase, line to line.
      b. Input current, each phase, line to line.
      c. System output voltage, each phase, line to line.
      d. System output current, each phase.
      e. System output frequency.
      f. DC bus voltage.
      g. Battery current and direction (charge/discharge).
      h. Elapsed time-discharging battery.
   2. Basic Status Condition Indications:
      a. Normal operation.
      b. Load-on bypass.
      c. Load-on battery.
      d. Inverter off.
      e. Alarm condition exists.
   3. Alarm Indications:
      a. Battery system alarm.
      b. Control power failure.

c. Fan failure.
d. Overload.
e. Battery-charging control faulty.
f. Input overvoltage or undervoltage.
g. Approaching end of battery operation.
h. Battery undervoltage shutdown.
i. Inverter fuse blown.
j. Inverter transformer overtemperature.
k. Inverter overtemperature.
l. Static bypass transfer switch overtemperature.
m. Inverter power supply fault.
n. Inverter output overvoltage or undervoltage.
o. System overload shutdown.
p. Inverter output contactor open.
q. Inverter current limit.

4. Controls:
   a. Inverter on-off.
   b. Start.
   c. Battery test.
   d. Alarm silence/reset.
   e. Output-voltage adjustment.

D. Dry-form "C" contacts shall be available for remote indication of the following conditions:
   1. Inverter on battery.
   2. Inverter on-line.
   3. Inverter load-on bypass.
   4. Inverter in alarm condition.
   5. Inverter off (maintenance bypass closed).

E. Include the following minimum array:
   1. Ready, normal-power on light.
   2. Charge light.
   3. Inverter supply load light.
   4. Battery voltmeter.
   5. AC output voltmeter with minimum accuracy of 2% of full scale.
   6. Load ammeter.
   7. Test switch to simulate ac failure.

F. Enclosure: Steel, with hinged lockable doors, suitable for wall or floor mounting. Manufacturer's standard corrosion-resistant finish.

2.10 OPTIONAL FEATURES:

A. Emergency-Only Circuits: Automatically energize only when normal supply has failed. Disconnect emergency-only circuits when normal power is restored.

2.11 OUTPUT DISTRIBUTION SECTION:

A. Panelboard: Comply with SECTION 26 24 16 - PANELBOARDS except provide assembly integral to equipment cabinet.

2.12 SOURCE QUALITY CONTROL:

A. Factory test complete inverter system, including battery, before shipment. Include the following:
   1. Functional test and demonstration of all functions, controls, indicators, sensors, and protective devices.
   2. Full-load test.
   3. Transient-load response test.
   4. Overload test.
   5. Power failure test.

B. Observation of Test: Give 14 days' advance notice of tests and provide access for Owner's representative to observe tests at Owner's option.

C. Report test results. Include the following data:
   1. Description of input source and output loads used. Describe actions required to simulate source load variation and various operating conditions and malfunctions.
   2. List of indications, parameter values, and system responses considered satisfactory for each test action. Include tabulation of actual observations during test.
   3. List of instruments and equipment used in factory tests.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance.
   1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment will be installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

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

3.02 INSTALLATION:

A. Install system components on floor and attach by bolting.
   1. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See SECTION 26 05 48 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS for seismic-restraint requirements.
   2. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.03 CONNECTIONS:

A. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams, unless otherwise indicated.

B. Ground equipment according to SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

1. Separately Derived Systems: Make grounding connections to grounding electrodes and bonding connections to metallic piping systems as indicated; comply with NFPA 70.

C. Connect wiring according to SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES.

3.04 IDENTIFICATION:

A. Identify equipment and components according to SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS.

3.05 FIELD QUALITY CONTROL:

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Inspect interiors of enclosures for integrity of mechanical and electrical connections, component type and labeling verification, and ratings of installed components.
2. Test manual and automatic operational features and system protective and alarm functions.
3. Test communication of status and alarms to remote monitoring equipment.
4. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specifications. Certify compliance with test parameters.
5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.06 STARTUP SERVICE:

A. Engage a factory-authorized service representative to perform startup service.

B. Verify that central battery inverter is installed and connected according to the Contract Documents.

C. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.

D. Complete installation and startup checks according to manufacturer's written instructions.

3.07 ADJUSTING AND CLEANING:

A. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

B. Install new filters in each equipment cabinet within 14 days from date of Substantial Completion.

3.08 DEMONSTRATION:

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain central battery inverters.

END OF SECTION 26 33 23

SECTION 26 41 13 – LIGHTNING PROTECTION FOR STRUCTURES

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 lightning protection for structures and systems.

1.03 REFERENCED STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. NFPA

1. NFPA 780-2014: Standard for the Installation of Lightning Protection Systems (ANSI)

C. Underwriters Laboratories Inc.

1. UL 96-2005: Lightning Protection Components (ANSI)
2. UL 96A-2007: Installation Requirements for Lightning Protection Systems (ANSI)

1.04 SUBMITTALS:

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

B. Shop Drawings: For air terminals and mounting accessories.

1. Layout of the lightning protection system, along with details of the components to be used in the installation.
2. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.

C. Qualification Data: For qualified Installer and manufacturer. Include data on listing or certification by UL.

D. Certification, signed by Contractor, that roof adhesive is approved by manufacturer of roofing material.

E. Field quality-control reports.

F. Comply with recommendations in NFPA 780, Annex D, "Inspection and Maintenance of Lightning Protection Systems," for maintenance of the lightning protection system.

G. In accordance with NFPA 780, compliance of the completed installation with the requirements of this standard shall be certified through a physical onsite inspection by a qualified and impartial organization acceptable to the authority having jurisdiction.

H. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:

1. Ground rods.
2. Ground loop conductor.

1.05 QUALITY ASSURANCE:

A. Installer Qualifications: Certified by UL, trained and approved for installation of units required for this Project.

B. System Certificate:

1. UL Master Label.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

1.06 COORDINATION:

A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.
B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.
C. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.
D. Connect new lightning protection system to existing Patient Care Tower Lighting Protection system. New UL Master Label to be acquired for the entire facility.

PART 2 - PRODUCTS

2.01 LIGHTNING PROTECTION SYSTEM COMPONENTS:

A. Comply with UL 96 and NFPA 780.
B. Roof-Mounted Air Terminals: NFPA 780, Class II, aluminum unless otherwise indicated.
   1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
      (a) East Coast Lightning Equipment Inc.
      (b) ERICO International Corporation.
      (c) Harger.
      (d) Heary Bros. Lightning Protection Co. Inc.
      (e) Independent Protection Co.
      (f) Preferred Lightning Protection.
      (g) Robbins Lightning, Inc.
      (h) Thompson Lightning Protection, Inc.
C. Air Terminals More than 24 Inches (600 mm) Long: With brace attached to the terminal at not less than half the height of the terminal.
   1. Single-Membrane, Roof-Mounted Air Terminals: Designed specifically for single-membrane roof system materials. Comply with requirements in DIVISION 07 ROOFING SECTIONS.
D. Main and Bonding Conductors: Copper.
E. Ground Loop Conductor: The same size and type as the main conductor except tinned.
F. Ground Rods: As noted on plan.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install lightning protection components and systems according to UL 96A and NFPA 780.
B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends.
C. Conceal the following conductors:

1. System conductors.
2. Down conductors.
3. Interior conductors.

D. Conductors within normal view of exterior locations at grade within 200 feet (60 m) of building.

E. Cable Connections: Use crimped or bolted connections for all conductor splices and connections between conductors and other components. Use exothermic-welded connections in underground portions of the system.

F. Air Terminals on Single-Ply Membrane Roofing: Comply with roofing membrane and adhesive manufacturer's written instructions.

G. Bond extremities of vertical metal bodies exceeding 60 feet (18 m) in length to lightning protection components.

H. Ground Loop: Install ground-level, potential equalization conductor and extend around the perimeter of structure.

I. Bury ground ring not less than distance noted on drawings.
   1. Bond ground terminals to the ground loop.

J. Bond grounded building systems to the ground loop conductor within 12 feet (3.6 m) of grade level.

K. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 60-foot (18-m) intervals.

3.02 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS:

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in DIVISION 26 SECTION "SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING."

3.03 CORROSION PROTECTION:

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

3.04 FIELD QUALITY CONTROL:

A. Notify Owner’s Rep at least 48 hours in advance of inspection before concealing lightning protection components.

B. UL Inspection: Meet requirements to obtain a UL Master Label for system.

C. The lightning protection system and components shall be inspected by a UL certified inspection agency. This agency shall forward the inspection results and UL Master Certification; or UL Letter of Findings, as applicable, to the Owner’s Representative upon completion of the inspection. The Owner’s Representative shall be notified at least 48 hours in advance prior to any inspection by the UL inspector.

END OF SECTION 26 41 13

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SECTION 26 43 13 – SURGE PROTECTION DEVICES (SPD)

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 specifies Surge Protection Devices (SPD) of 1,000V or less of the following UL 1449 3rd Edition Types/Locations:
   1. Type 2: Located on load side of service disconnect.

B. The specified units shall be of the multi-stage parallel design and shall provide high energy transient voltage suppression, surge current diversion, high frequency attenuation, and line control for all electrical modes of equipment connected downstream from the units.

C. The devices shall be designed and manufactured by a qualified manufacturer of SPDs. The qualified manufacturer shall have been engaged in the commercial design and manufacture of such products for a minimum of three years.

1.03 RELATED REQUIREMENTS:

A. SECTION 26 05 10 - BASIC ELECTRICAL REQUIREMENTS

B. SECTION 28 31 00 – FIRE ALARM AND MASS NOTIFICATION SYSTEMS for surge protection for fire alarm circuits.

1.04 REFERENCE STANDARDS:

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   1. C62.11, “Metal-Oxide Surge Arresters for AC Power Circuits (>1 kV)”.
   2. C62.41, “IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits”.
   3. C62.45, “IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage (1,000V and Less) AC Power Circuits”.
   4. IEEE 1100 Emerald Book, “Recommended Practice for Powering and Grounding Electronic Equipment”.

B. Canadian Standards Association (CSA).

C. National Electrical Manufacturers Association (NEMA)

D. National Fire Protection Association (NFPA):
   1. NFPA 70, “National Electric Code (NEC)”.
   2. NFPA 75, “Standard for the Protection of Electronic Computer/Data Processing Equipment”.
   3. NFPA 780, “Standard for the Installation of Lightning Protection Systems”.

E. Underwriters Laboratories (UL):
   1. UL 1283, “UL Standard for Safety Electromagnetic Interference Filters”.
   2. UL 1449, “UL Standard for Safety Surge Protective Devices”, 3rd Edition.

F. Military Standard (MIL-STD):
   1. MIL-STD-220C, “Method of Insertion Loss Measurement”.

G. The devices shall be UL 1449 (3rd Edition) Listed, CSA Approved and UL 1283 (5th Edition) Listed as Electromagnetic Interference Filters.

1.05 DEFINITIONS:

A. MCOV: Maximum Continuous Operating Voltage
B. MOV: Metal Oxide Varistors
C. SAD: Silicon Avalanche Diodes
D. SCCR: Short Circuit Current Rating
E. SPD: Surge Protection Device
F. VPR: Voltage Protection Rating

1.06 SUBMITTALS:

A. Refer to DIVISION 01 and SECTION 26 05 10 - BASIC ELECTRICAL REQUIREMENTS, for administrative and procedural requirements for Submittals.
B. Includes, but is not limited to, the following:
   1. The manufacturer shall provide Equipment catalog data, technical information, specifications, installation manuals, start-up and operating instructions.
   2. Copies of documentation stating the surge protection device is UL 1283 and UL 1449 tested and listed.
   3. Copies of actual let through voltage data in the form of oscilloscope results for both IEEE C62.41 Category C3 (combination wave) and B3 (Ring wave) tested in accordance with IEEE C62.45.
   4. Copies of Noise Rejection testing. Noise rejection is to be measured between 50 kHZ and 100 MHz verifying the devices noise attenuation. Must show multiple attenuation levels over a range of frequencies.
   5. Copies of UL test reports, which verify the suppressor components can survive published surge current rating on a per mode basis using the IEEE C62.41 impulse waveform C3 (8 by 20 microsecond, 20 kV/10 kA). Test data on an individual module is not acceptable.
   6. Copy of warranty statement clearly establishing the terms and conditions to the building/facility owner/operator.

1.07 WARRANTY:

A. The manufacturer shall provide a ten-year limited warranty on defective material and workmanship from the date of shipment when installed in compliance with applicable national/local electrical codes, and the manufacturer's installation, operation, and maintenance instructions.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Subject to compliance with requirements, provide SPD units manufactured by one of the following:
   1. Eaton/Innovative Technology.
   2. Thomas & Betts/Current Technology.
   3. Smiths Power/LEA International.
   4. Advanced Protection Technologies (APT).
B. All other manufacturers shall submit detailed compliance or exception statements to all provisions of this Specification, at least 10 days prior to Bid opening to allow consideration. Additionally, manufacturers shall submit independent test data from a nationally recognized

testing laboratory verifying the following: Life cycle testing, overcurrent protection, UL 1449, noise attenuation, and surge current capacity.

2.02 GENERAL:

A. SPD units shall be compatible with the electrical system, voltage, current, and distribution configuration indicated. Service entrance rated units shall contain an integral fused disconnect switch. Indoor unit enclosures shall be NEMA Type 1. Outdoor unit enclosures shall be NEMA Type 3R.

B. The unit shall include an engineered suppression system, using arrays of individually fused nonlinear voltage dependent metal oxide varistors (MOVs) with matched operating characteristics.
   1. The suppression system shall not use gas tubes, spark gaps, or silicon avalanche diodes (SADs).
   2. The modules shall be constructed in a manner that ensures surge current sharing.
   3. All internal connections associated with the suppression filter system and subject to surge currents shall use low-impedance copper bus bar and appropriately sized copper wire.
   4. Internal connections associated with the suppression filter system and subject to surge currents shall be made with solderless compression type lugs and shall be bolted to the bus bars in order to reduce overall system impedance.
   5. No plug-in component modules, quick-disconnect terminal, nonfield replaceable fusing, or printed circuit boards shall be used in surge current carrying paths.

C. Unit Status Indicators:
   1. The unit shall include externally visible LED visual status indicators that monitor the on-line status of each phase of the unit.

2.03 SPD PERFORMANCE AND TESTING:

A. Declared Maximum Continuous Operating Voltage (MCOV) shall be greater than 115% of the nominal system operating voltage and in compliance with test and evaluation procedures outlined in the nominal discharge surge current test of UL 1449 3rd Edition, Section 37.7.3. MCOV values claimed based on the component's value or on the 30-minute 115% operational voltage test, Section 38 in UL 1449 will not be accepted.

B. Protection Modes: In accordance with NEMA standard LS 1, the unit shall provide protection in all modes. Wye configured systems shall provide Line-to-Neutral, Line-to-Ground, Line-to-Line, and Neutral-to-Ground protection. Delta configured systems shall provide Line-to-Line protection in ungrounded systems, and Line-to-Line and Line-to-Ground protection in grounded systems.

C. Peak Surge Current Rating: Based on IEEE C62.41, the tested peak surge current rating shall be no less than as follows:
   1. Service Entrance: 100 kA per mode, 200 kA per phase.
   2. Distribution Panelboards: 80kA per mode, 160 kA per phase.
   3. Branch Panelboards: 50kA per mode, 100 kA per phase.

D. Minimum Repetitive Surge Current Capacity: The Service Entrance SPD shall be capable of surviving 1,000 category C3 (10 kA) surge currents as described in IEEE C62.41.

E. Unit shall have not more than 10% deterioration or degradation of the UL 1449 3rd Edition Voltage Protection Rating (VPR) due to repeated surges. All voltage protection requirements in the following table shall be met:

System Voltage	Mode	B3 Ringwave	B3/C1 Comb. Wave	C3 Comb. Wav	UL 1449 3rd Edition VPR
240/120	L-N	420	642	1040	800
208Y/120	L-G	480	690	1300	800
	N-G	340	620	1240	800
	L-L	610	1010	1420	1200
480Y/277	L-N	660	910	1490	1200
	L-G	750	1068	1830	1200
	N-G	720	974	1690	1200
	L-L	960	1700	2290	1800

F. The UL 1449 Nominal Discharge Surge Current Rating shall be 20 kA.

G. The short circuit current rating (SCCR) shall be 200 kAIC without requiring an upstream protection device for safe operation.

H. High Frequency Extended Range Power Filter:
   1. The unit shall include a high frequency extended range power filter and shall be UL 1283 listed as an Electromagnetic Interference Filter.
   2. The filter shall reduce fast rise-time, high frequency, error-producing transients, and electrical line noise to harmless levels, thus eliminating disturbances which may lead to electronic system upset.
   3. The system shall be tested to MIL-STD 220C for electrical line noise attenuation per 50 ohm insertion loss measurement method of RF frequencies up to 100 MHz.
   4. Noise attenuation for electric noise shall be 33 dB at 100 kHz and no more than 32 dB at all other frequencies.

I. Overcurrent Protection: All components, including suppression, filtering, and monitoring components, shall be individually fused and rated to allow maximum specified surge current capacity.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install the SPD with insulated copper conductors sized per the manufacturer's recommendations.

B. Conductors connecting the SPD to the system shall be connected directly to a feeder/branch circuit breaker to allow the unit to be isolated for removal and/or repair.

C. The conductors shall be as short and straight as possible. Panelboard phase, neutral and ground buses and circuit breaker serving the SPD shall be arranged for a maximum external-mounted SPD lead length of six inches. SPDs shall be mounted integral in service-entrance switchboards and lead length shall not exceed six inches. If lead length must exceed six inches, notify the Engineer.

D. The conductors shall be twisted together to reduce the SPD system input impedance.

E. The SPD shall be installed following the SPD manufacturer's recommended practices and in compliance with all applicable codes.

F. The UL 1449 Voltage Protection Rating (VPR) shall be permanently affixed to the SPD unit.

G. The SPD manufacturer's technician shall perform a system checkout and start-up in the field to assure proper installation, operation and to initiate the warranty of the system. The technician shall do the following:
   1. Verify voltage clamping levels.
   2. Verify N-G connection.
   3. Record information to product signature card for each product installed.

END OF SECTION 26 43 13

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SECTION 26 51 00 – LED INTERIOR LIGHTING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification sections, apply to this SECTION.

1.02 SUMMARY:

A. SECTION Includes:
   1. Lighting fixtures.
   2. Exit signs.
   3. Lighting fixture supports.

B. Related sections:
   1. SECTION 26 27 26 – WIRING DEVICES

1.03 REFERENCES:

A. Applicable Standards: Comply with applicable requirements of the following standards.
   1. American National Standards Institute (ANSI)/Institute of Electrical and Electronic Engineers (IEEE):
      a. ANSI/IEEE C62.41-1991 - Recommended Practice for Surge Voltages in Low-Voltage A.C. Power Circuits.
   2. National Electrical Manufacturers Association (NEMA):
      a. LE-2 - Lighting System Noise Criterion (LS-NC) Ratings.
   3. National Fire Protection Association (NFPA):
      a. 70 - National Electrical Code (NEC). Comply with applicable local code requirements of the authority having jurisdiction and the NEC.
   4. Underwriters Laboratories (UL): Provide interior lighting fixtures and components which are UL-listed and labeled.
      a. 57 - Electric Lighting Fixtures.
      b. 486A-486B - Wire Connectors.
      c. 924 – Standard for Emergency Lighting and Power Equipment.

1.04 DEFINITIONS:

A. CCT: Correlated color temperature.
B. CRI: Color-rendering index.
C. LER: Luminaire efficacy rating.
D. Lumen: Measured output of lamp and luminaire, or both.
E. Luminaire: Complete lighting fixture, including ballast housing if provided.

1.05 SUBMITTALS:

A. Product Data:
   1. For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
      a. Physical description of lighting fixture including dimensions.
      b. Energy-efficiency data.
      c. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.

d. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type.

2. Lighting Inverter: Include data on features, accessories, finishes.
3. Emergency Lighting Control Unit: Include data on features, accessories, finishes.

B. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in DIVISION 01 include the following:
1. Lighting Inverter product data, installation manual, and operating manual.
2. Emergency Shunt Relay product data, installation manual, and operating manual.

1.06 QUALITY ASSURANCE:

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. Comply with NFPA 70.

1.07 COORDINATION:

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, fire alarm system, and partition assemblies.

1.08 WARRANTY:

A. Manufacturer's standard form in which manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Products: Subject to compliance with requirements, provide products indicated on Drawings or Owner approved equal.

2.02 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Luminaires and lighting equipment shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

2.03 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS:

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
B. Metal Parts: Free of burrs and sharp corners and edges.
C. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally when secured in operating position.
E. Diffusers and Globes:

1. Acrylic Lighting Diffusers: 100% virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
   a. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
   b. UV stabilized.

2.04 LED DRIVERS:

A. LED drivers shall meet the following requirements:
   1. Drivers shall have a minimum efficiency of 85%
   2. Starting Temperature: -40 degrees F.
   3. Input Voltage: 120 to 277V (plus or minus 10%)
   4. Power supplies: Class I or II output.
   5. Power Factor (PF): greater than or equal to 0.90.
   6. Total Harmonic Distortion (THD): Less than or equal to 20%.
   7. Comply with FCC Title 47 CFR Part 18 Non-consumer RFI/EMI Standards.
   8. Drivers shall be reduction of hazardous substances (ROHS) compliant.
   9. 0-10V continuous dimming capability with a range of 10% to 100%. Provide 1% to 100% dimming capability where shown on drawings.

2.05 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.
C. Exit signs shall be connected to unswitched emergency power.

2.06 LED SOURCES

A. LED light sources shall meet the following requirements:
   1. Operating temperature rating shall be between -40 degrees F to 120 degrees F.
   2. Correlated Color Temperature (CCT): 3500K or as scheduled.
   3. Color Rendering Index (CRI): greater than or equal to 80.
   4. Average rated life of 50,000 hours at 70% lumen output (L70).

2.07 LIGHTING FIXTURE SUPPORT COMPONENTS:

A. Comply with SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS for channel- and angle-iron supports and nonmetallic channel and angle supports.
B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
D. Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 12 gage.
E. Chain: Heavy duty type, provided with light fixture.
F. Wires for Humid Spaces: ASTM A580/A580M, Composition 302 or 304, annealed stainless steel, 12 gage.

2.08 EMERGENCY SHUNT RELAY:

A. Description: Normally closed, electrically held relay, arranged to provide all required functionality to allow any standard lighting control device to control emergency lighting in conjunction with normal lighting; complying with UL 924.

1. Allow control of emergency lighting fixtures in tandem with normal lighting in an area while ensuring that emergency lighting will turn on immediately to full brightness upon loss of normal power supplying the control device. Emergency lighting operation shall be independent for each controlled area and shall not require a generalized power failure for proper operation.
    a. The unit shall automatically switch emergency lighting on and off as normal lighting is switched. When normal power is not available, the unit shall force and hold emergency lighting on regardless of the state of any external control device until normal power is restored.
2. Mounting: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
3. Normally closed dry contacts capable of switching 20 amp LED driver loads at 120-277 VAC, 60 Hz.
4. Universal rated voltage inputs provided for normal power sense and normal switched power at 120-277 VAC, 60 Hz.
5. Provide separate LEDs to indicate the presence of normal and emergency power sources. The LEDs shall indicate the unit's current operational mode (normal or emergency).
6. The device's normal power input lead shall be connected to the line side of the control device such that any upstream fault causing a loss of power, including the tripping of the branch circuit breaker, will force the unit into the emergency mode and turn on the emergency lighting.
7. Unit shall utilize zero crossing circuitry to protect relay contacts from the damaging effects of inrush current generated by switching electronic ballast loads.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Lighting fixtures:
    1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.

B. Temporary Lighting: If it is necessary, and approved by Owner, 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. Lay-in Ceiling Lighting Fixtures Supports: Use grid as a support element.
    1. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
    2. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
    3. Install two independent support rods or wires from structure to a tab on opposing corners of lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

D. Suspended Lighting Fixture Support:
    1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
    2. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.

E. Connect wiring according to SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES.
F. Ensure all moisture and debris have been removed from in-grade light fixtures prior to installation. Seal conduit entries at exterior and in-grade light fixtures to prevent infiltration of moisture, debris and insects.

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 05 53 - ELECTRICAL IDENTIFICATION.

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.

END OF SECTION 26 51 00

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SECTION 27 10 00 - STRUCTURED CABLING 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. This SECTION includes the following scope of work. This contractor shall provide rough-in for all communications, life-safety, security, and specialty healthcare systems listed below and/or indicated on the telecommunications and security drawings. In some cases, this contractor shall provide installation labor only for products and/or systems supplied by MU. Reference the IT Responsibility Matrix on the drawings for additional information.
   1. Structured Cabling rough-in.
   2. Structured Cabling Pathways and Supports.
   3. Structured Cabling Pathways Firestopping.
   4. Structured Cabling Grounding and Bonding system.
   5. UTP Cabling – Horizontal (Cable installation only).
   6. Coaxial Cabling (Cable installation only).
   7. Nurse Call System (Rough-in only).
   8. Cellular Distributed Antenna System (Rough-in and cable installation only).
   9. Access Control System (Rough-in and cabling installation only).
   10. Video Surveillance Camera System (Rough-in and cabling installation only).
   11. Telemetry Monitoring System (Rough-in only).
   12. Audio/Visual Systems (Rough-in and cabling installation only).

1.03 RELATED REQUIREMENTS:

A. DIVISION 06 – "ROUGH CARPENTRY."
B. DIVISION 08 – "DOOR HARDWARE."
C. DIVISION 09 – "INTERIOR PAINTING."
D. DIVISION 11 – "EQUIPMENT."
E. DIVISION 26 – "RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS."

1.04 REFERENCE STANDARDS (CURRENT VERSION AND ALL ADDENDUMS):

A. American National Standards Institute (ANSI).
   1. ANSI/BICSI 004, "Information Technology Systems Design and Implementation Best Practices for Healthcare Institutions and Facilities."
   2. ANSI/TIA-568.0, "Generic Telecommunications Cabling for Customer Premises."
   3. ANSI/TIA-568.1, "Commercial Building Telecommunications Infrastructure Standard."
   4. ANSI/TIA-568.2, "Balanced Twisted-Pair Telecommunications Cabling and Components Standard."
   5. ANSI/TIA-568.3, "Optical Fiber Cabling and Components Standard."
   6. ANSI/TIA-568.4, "Broadband Coaxial Cabling Components Standard."
   7. ANSI/TIA-569, "Telecommunications Pathways and Spaces."
   8. ANSI/TIA-606, "Administration Standard for Telecommunications Infrastructure."
   9. ANSI/TIA-607, "Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises."
B. American Society for Testing and Materials (ASTM)

1. ASTM B633, “Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel”

C. Building Industry Consulting Service International (BICSI)
   1. BICSI, "Information Technology Systems Installation Methods Manual (ITSIMM)."
   2. BICSI, "Telecommunications Distribution Methods Manual (TDMM)."
   3. Electronic Components Industry Association (ECIA)EIA/ECA-310-E, “Cabinets, Racks, Panels and Associated Equipment”

D. Insulated Cable Engineering Association (ICEA)
   1. ANSI/ICEA S-83-596, “Standard for Fiber Optic Premises Distribution Cable”
   2. ANSI/ICEA S-116-732 (NEMA WC 66), “Standard for Category 6 and 6A, 100 Ohm, Individually Unshielded Twisted Pairs, Indoor Cables (With or Without an Overall Shield) For Use in LAN Communication Wiring Systems.”

E. International Organization for Standardization / International Electrotechnical Commission. (ISO/IEC)
   1. ISO/IEC 11801, "Generic Cabling for Customer Premises."

F. National Electrical Contractors Association (NECA)
   1. NECA 1, “Standard Practice of Good Workmanship in Electrical Construction”

G. National Electrical Manufacturers Association (NEMA)
   1. NEMA 250, “Enclosures for Electrical Equipment (1,000 V Maximum)”
   2. NEMA WD-6, “Locking Plugs and Receptacles”

H. National Fire Protection Association (NFPA)
   1. NFPA 70, “National Electric Code (NEC)”
   2. NFPA 262, “Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces’

I. Underwriters Laboratories (UL)
   1. UL 94, “Flame Rating”
   2. UL 444, “Communications Cables”
   3. UL1363, “Re-locatable Power Taps”
   4. UL1651, “Optical Fiber Cable”

1.05 DEFINITIONS:

A. ANSI: American National Standards Institute.
B. AWG: American Wire Gage.
C. BICSI: Building Industry Consulting Service International.
D. CMP: Communications Plenum Cable
E. CSA: Canadian Standards Association.
F. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
G. EMI: Electromagnetic interference.
H. ESD: Electrostatic Discharge
I. FOCIS: Fiber Optic Connector Intermateability Standards.
J. HVAC: Heating, Ventilation and Air Conditioning.
K. IDC: Insulation displacement connector.
L. ICEA: Insulated Cable Engineering Association.
M. IDC: Insulated-Displacement Connector
N. IMC: Intermediate Metal Conduit.

O. ISO/IEC: International Organization for Standardization / International Electrotechnical Commission.
P. ITSIMM: Information Technology Systems Installation Methods Manual
Q. LAN: Local area network.
R. LED: Light Emitting Diode
S. LEED®: Leadership in Engineering and Environmental Design.
T. MU: University of Missouri
U. MUHC: University of Missouri Healthcare
V. MU IT: University of Missouri Information Technology Team
W. NECA: National Electrical Contractors Association
X. NEMA: National Electrical Manufacturers Association
Y. NFPA: National Fire Protection Association
Z. NRTL: Nationally Recognized Testing Laboratories.
AA. OFCP: Optical fiber, conductive, plenum
BB. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.
CC. PVC: Polyvinyl Chloride.
DD. RCDD: Registered Communications Distribution Designer.
EE. RU: Rack Unit
FF. STP: Shielded twisted pair.
GG. TDMM: Telecommunications Distribution Methods Manual
HH. TIA: Telecommunication Industry Association
II. TV: Television.
JJ. UL: Underwriters Laboratories
KK. UTP: Unshielded twisted pair.
LL. VOC: Volatile Organic Compounds.

1.06 PERFORMANCE REQUIREMENTS:

A. General Performance: Backbone and horizontal cabling system shall comply with transmission standards in ANSI/TIA-568.2, when tested according to test procedures of this standard.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
C. Grounding: Comply with ANSI/TIA-607.
D. Seismic design of mounting and support components of the telecommunications systems shall meet seismic design category C, risk category IV. All components shall be designed and installed in accordance with ASCE 7-16, Chapter 13 and DIVISION 26 SECTION "SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS."

1.07 ADMINISTRATIVE REQUIREMENTS:

A. Pre-installation Conference: Conduct conference at Project Site with representatives from the Design Team and MU.

1.08 SUBMITTALS:

A. Product Data: For each type of product to be supplied by this contractor. Clearly indicate on product sheet which product is being proposed if multiple options are available. Clearly indicate which, if any, accessories are being proposed with the product. Failure to indicate specific product information may require re-submission of product data.

B. Product Data (supplied by others): Products to be supplied by MU or others shall have product data submitted by those entities for coordination with this contractor.
C. Shop Drawings:
   1. Telecom Room layout details including wall elevations showing actual size of components to be installed.
   2. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
      a. Vertical and horizontal offsets and transitions.
      b. Clearances for access above and to side of cable trays.
      c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
      d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.
D. LEED® Submittals:
   1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers for communications pathways, documentation including printed statement of VOC content.
E. Qualification Data: For Installer, qualified layout technician, and installation supervisor.
F. Field quality-control reports.

1.09 QUALITY ASSURANCE:
A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on permanent staff.
   1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings.
   2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician who shall be present at all times when Work of this SECTION is performed at Project Site.

1.10 DELIVERY, STORAGE, AND HANDLING:
A. Confirm cabling and equipment supplied by MU IT or system vendors to be installed by this contractor is free of visible defects and has been factory or field tested prior to installation.

1.11 PROJECT SITE CONDITIONS:
A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.12 SEQUENCING AND SCHEDULING:
A. Coordinate layout and installation of telecommunications pathways, equipment, cabling, and rooms with the Owner and the Owner's telecommunications and LAN equipment and service suppliers. Coordinate requirements with submitted Shop Drawings as well as construction scheduling and phasing with other affected trades.

1.13 MAINTENANCE:
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Plenum-rated hook and loop (Velcro) cable ties: Bag of 50 for each TR.

1.14 STRUCTURED CABLING UNIT PRICES:

A. Unit Price 27-1 - Structured Cabling outlet: Provide a unit price for an additional communications outlet including installation of backbox, conduit, and cabling. Cabling to be supplied and terminated by MU IT. Assume 225 feet of cable length installed in new construction in unfinished ceilings. All material shall meet the requirements of DIVISION 27.

PART 2 - PRODUCTS

2.01 STRUCTURED CABLING ROUGH-IN REQUIREMENTS:

A. Provide all required outlet boxes and junction boxes.
B. Provide all raceways and conduits (minimum 1-1/4 inches). Install pull-string in all raceways and conduits, 1-1/2 inches or less. For 2 inches or larger, use #14 AWG zinc coated steel or monofilament plastic line having not less than 200 lb. tensile strength. Leave not less than 12 inches of slack at each end of the pull string or pull wire inside boxes.
C. Provide conduit from each voice outlet or handset outlet, each structured cabling outlet and each TV/AV outlet to the nearest accessible ceiling space. Support cabling with non-continuous supports such as J-hooks until reaching the telecommunications cable tray or telecommunications room (TR). Install non-metallic threadless insulating bushings on end of all conduits.
D. Conduit Stub ups from Floor: All locations other than in a wall, provide IMC conduits with threaded steel couplings set flush with finish floor. Extend 6 inches above finish floor with IMC before any conversion. If conduit(s) do not extend up into equipment enclosures, etc., the IMC conduit(s) shall extend a minimum 6 inches above finished floor and be provided with nonmetallic insulating bushings.
E. Except in concrete or masonry walls, use of PVC conduits through floor slabs and above floor level is unacceptable.
F. Raceways 2 inch and smaller installed in interior spaces shall not exceed 150 feet in length. All raceways installed shall not contain more than two 90-degree bends or the equivalent. Provide pull boxes or junction boxes as necessary to comply with these requirements, whether or not indicated.
G. Bends in conduits shall be long sweep radius bends and in no instance shall the inside radius of bends be less than ten times the internal diameter for all conduit sizes.
H. Provide all mounting boards sized as indicated, minimum 3/4-inch-thick AC plywood. Paint all mounting boards on the smooth side with two (2) coats alkyd enamel. Paint color to match wall color. Do not paint over one label.
I. Provide for equipment grounding connections and grounding requirements at all equipment terminal systems and mounting boards.
J. Typical structured cabling outlet conduit requirements: Minimum 1-1/4 inches.
K. Typical voice handset outlet only conduit requirements: Minimum 1-1/4 inches.
L. All device outlet boxes shall be minimum 4-inch square by 3-1/2-inch deep, with single or two gang plaster rings. Provide single-gang plaster ring for cabling locations with six cables or less indicated. Provide two-gang rings for outlets with over six cables indicated.
M. Video (TV/AV) outlets: Provide and install 1-1/2-inch conduit to dedicated video (TV) locations and stub to nearest accessible ceiling space. Special multi-service monitor backboxes shall be used behind all monitor/TV locations (except in patient rooms) to terminate power,

telecommunications, and AV cabling. Refer to telecommunications details for additional information.

2.02 STRUCTURED CABLING PATHWAYS AND SUPPORTS:

A. General Requirements: Comply with ANSI/TIA-569.

B. Cable Support: NRTL labeled for support of Category 6 or higher cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
   1. Support brackets with cable tie slots for fastening cable ties to brackets.
   2. Lacing bars, spools, J-hooks, and D-rings shall be provided as required for the support application.
      a. Cabling support from building structure when cable tray is not available shall be a flexible and non-metallic support that provides support of Category 5 or higher UTP cabling and/or fiber optic cable without sagging, bending or damaging the cable. Unit shall support up to a 5-inch diameter bundle of cable. Unit shall be UL/CSA listed for environmental air handling spaces per NFPA 70. Support shall be Arlington Industries TL50P or prior approved equal.
      b. Cable bundles shall be bound with plenum rated, hook and loop (Velcro) type straps. Plastic tie-wraps are unacceptable.

C. Basket Style Cable Trays:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
      a. Chatsworth Products, Inc. (CPI).
      b. Cooper B-Line.
      c. Legrand Cablofil, Inc.
      d. Mono Systems.
      e. Snake Tray.
   2. Description: UL listed basket style cable tray, 12-inches wide and 4 inches deep (or size as shown on the drawings), electroplated zinc galvanized finish applied after fabrication. Tray meets ASTM B633 with average thickness of 0.7 mils. Tray shall be UL classified for suitability as an equipment grounding conductor.

D. Cable Ladder Style Cable Trays (cable ladder shall be used in telecommunications spaces only and supplied by MU; exceptions where contractor requires cable ladder for vertical support of cabling bundles outside of telecommunications spaces):
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
      a. Chatsworth Products, Inc. (CPI).
      b. Cooper B-Line.
      c. Legrand Cablofil, Inc.
      d. Mono Systems.
      e. Snake Tray.
   2. Steel tubing, rectangular in cross-section with cross members welded at 12-inch intervals. UL classified for suitability as an equipment grounding conductor, black finish. Provide accessories such as radius bends to maintain cable bending radius along tray. Provide a cable radius drop at all locations where cabling drops out of tray. Provide other accessories such as standoff kits, rack-to-tray mounting kits, wall mounting brackets, etc., as required for installation.

E. Backboards:

1. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements in DIVISION 06 SECTION "ROUGH CARPENTRY" for plywood backing panels.

2.03 STRUCTURED CABLING FIRESTOPPING AND SMOKE/ACOUSTICAL PATHWAYS:

A. UL Listed Fire-rated Cabling Pathway: Provide fire rated horizontal pathways in configurations and locations as shown on the Drawings or where required to pass cabling through fire rated walls. See Architectural code plan for locations of fire rated partitions. Follow all manufacturers' recommendations to provide a UL listed installation with an "F" and "S" rating that matches that of the partition. Provide ganged wall plates for multiple pathway installations and label with manufacturer provided labels. Provide EZ-Path Series 44 by Specified Technologies (STI). All required pathways needed to transition cabling through fire-rated partitions shall be provided by the DIVISION 27 Contractor.

B. Cabling penetrations through non-fire-rated partitions shall utilize the EZ-Path Series 33NEZ smoke and acoustical pathway to allow cable transition through the partitions while maintaining the partitions smoke and acoustical barrier properties.

2.04 STRUCTURED CABLING GROUNDING AND BONDING SYSTEM:

A. Comply with requirements in DIVISION 26, SECTION "GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS" for grounding conductors and connectors. All grounding conductors, busbars, and terminations shall be provided by the DIVISION 26 Contractor.

B. Comply with ANSI/TIA-607.

2.05 FIBER OPTIC CABLING - HORIZONTAL:

A. All horizontal fiber optic cabling shall be supplied to the contractor by MU. Coordinate delivery and installation requirements with MUHC representatives.

2.06 FIBER OPTIC TERMINATION HARDWARE AND ENCLOSURES:

A. All fiber optic termination hardware and enclosures shall be supplied by MU, and all final terminations shall be performed by MU IT. Coordinate delivery and installation requirements with MUHC representatives.

2.07 UTP CABLING - HORIZONTAL:

A. All horizontal UTP cabling shall be supplied to the contractor by MU. Coordinate delivery and installation requirements with MUHC representatives.

2.08 UTP TERMINATION HARDWARE:

A. All UTP termination hardware shall be supplied by MU, and all final terminations shall be performed by MU IT. Coordinate delivery and installation requirements with MUHC representatives.

2.09 COAXIAL CABLING AND CONNECTORS:

A. All coaxial cabling shall be supplied to the contractor by MU, and all final terminations shall be performed by MU IT. Coordinate delivery and installation requirements with MUHC representatives.

2.10 TELECOMMUNICATIONS RACKS AND ACCESSORIES:

A. All telecommunications racks and accessories shall be provided and installed by MU IT. Coordinate installation requirements with MUHC representatives.

2.11 TELECOMMUNICATIONS CABINETS AND ACCESSORIES:

A. All telecommunications cabinets and accessories shall be provided and installed by MU IT. Coordinate installation requirements with MUHC representatives.

2.12 CABLING SYSTEM IDENTIFICATION PRODUCTS:

A. All cable identification and labeling shall be provided and installed by MU IT.

PART 3 - EXECUTION

3.01 WIRING METHODS:

A. Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces where unenclosed wiring method may be used. Conceal pathways and cables except in unfinished spaces. In unfinished spaces where surface mounted devices are used, install structured cabling outlets in surface mounted boxes and provide conduit up to a minimum of 10 ft-0 inches above finished floor.
   1. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
   2. Wiring within Enclosures:
      a. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
      b. Install lacing bars and distribution spools.
      c. Install conductors parallel with or at right angles to sides and back of enclosure.

3.02 INSTALLATION OF CABLES:

A. Comply with NECA 1.
B. General Requirements for Cabling:
   1. Comply with ANSI/TIA-568.1.
   2. Comply with BICSI ITSIMM, Ch. 6, "ICT Cables and Connecting Hardware."
   3. MU IT shall install 66-style IDC termination hardware unless otherwise indicated.
   4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
   6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
   7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
   8. Do not install cabling supports from ductwork or other non-structural elements.
   9. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
   10. In the communications equipment room, install 20-foot (6-m) long slack on each cable.

11. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
12. Coordinate installation of identification labels for raceways, junction boxes, and pull boxes that are dedicated to telecommunications and security. Labels shall meet the requirements of Division 26 section, "Identification for Electrical Systems."

C. UTP Cable Installation:
1. Comply with ANSI/TIA-568.2.
2. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.

D. Optical Fiber Cable Installation:
1. Comply with ANSI/TIA-568.3.

E. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches (1524 mm) apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Installation of Cable Routed Exposed under Raised Floors:
1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 6 feet (1800 mm) long not less than 12 inches (300 mm) in diameter below each feed point. Attach coil to nearest floor pedestal from termination point or point cable bundle is routed through flooring.

G. Separation from EMI Sources:
1. Comply with BICSI TDMM and ANSI/TIA-569 for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).

c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.03 FIRESTOPPING:

A. Comply with requirements in DIVISION 07 - PENETRATION FIRESTOPPING AND THE REQUIREMENTS of this SECTION.
B. Comply with ANSI/TIA-569, Annex A, "Firestopping."
C. Comply with BICSI TDMM, "Firestop Systems" Article.

3.04 GROUNDING:

A. Install grounding according to BICSI TDMM Chapter 8, "Bonding and Grounding (Earthing)" Chapter.
B. Comply with ANSI/TIA-607.
C. Coordinate with DIVISION 26 to locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Coordinate with DIVISION 26 to install Telecommunications Bonding Backbone conductors to building service ground.
D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.05 FIELD QUALITY CONTROL:

A. Perform the following tests and inspections:
   1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings.
   2. Visually inspect cable placement and grounding and bonding of all equipment.

END OF SECTION 27 10 00

PART 1 - SECTION 28 31 11 – 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.

B. Related Sections:

1. DIVISION 01 - GENERAL REQUIREMENTS
2. DIVISION 07 - THERMAL AND MOISTURE PROTECTION (PENETRATION FIRESTOPPING)
3. DIVISION 08 - OPENINGS, (DOOR HARDWARE)
4. DIVISION 13 - SPECIALTY CONSTRUCTION
5. DIVISION 21 - FIRE SUPPRESSION
6. DIVISION 23 - HEATING VENTILATING AND AIR CONDITIONING MONITORING & CONTROL (HVAC)
7. DIVISION 26 - ELECTRICAL (COMMON WORK RESULTS FOR ELECTRICAL)
8. DIVISION 28 - ELECTRONIC SAFETY AND SECURITY

1.02 SUMMARY:

A. SECTION Includes:

1. This specification describes modifications to an addressable Fire Detection and alarm signaling system. The existing Siemens Desigo Modular control panel is intelligent device addressable, analog detecting, low voltage and modular, with digital communication techniques, in full compliance with all applicable codes and standards. The system modifications shall include all required hardware, raceways, interconnecting wiring and software to accomplish the requirements of this specification and the contract drawings, whether or not specifically itemized herein.
2. All equipment furnished shall be new and the latest state-of-the-art products of a single manufacturer, engaged in the manufacturing and sale of analog fire detection devices for over 35 years. Existing appliances may be relocated as necessary for the scope of the project.
3. The system as specified shall be supplied, installed, tested and approved by the local Authority Having Jurisdiction, and turned over to the owner in an operational condition.
4. In the interest of job coordination and responsibilities, the installing contractor shall contract with a single supplier for fire alarm equipment, engineering, programming, inspection and tests.

1.03 DEFINITIONS:

A. AHJ: Authority Having Jurisdiction. Local authority (such as a fire marshal), presiding over the occupancy of the building(s).
B. ASME: American Society of Mechanical Engineers.
C. Broadcast Media: The speakers, radio, cell phone, and other media that will carry the selected message to the selected audience.
D. FACP: Fire alarm control panel.
E. FM: FM Global (Factory Mutual).
F. Furnish: To supply the stated equipment or materials.
G. Install: To set in position and connect or adjust for use.
H. LED: Light-emitting diode.

I. LOC: Local Operating Console.
J. Listed: Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services. In accordance with NFPA all equipment, materials or services shall be listed by an approval agency including the following – UL, FM or other acceptable agencies. This project is insured by FM Global and it is desirable to utilize equipment that is listed in the Factory Mutual approval guide. UL standards are included as a basis-of-design.
K. NFPA: National Fire Protection Association. Definitions in NFPA 72 apply to fire alarm terms used in this SECTION.
L. NICET: National Institute for Certification in Engineering Technologies.
M. Provide: To furnish and install the stated equipment or materials.
N. UL: Underwriters Laboratories.

1.04 SYSTEM DESCRIPTION: Basic Desigo® Fire Safety Modular System - The existing system shall modified in accordance with all applicable codes, standards and owner's requirements.

1.05 PERFORMANCE REQUIREMENTS:

A. General Performance: System devices shown shall comply with NFPA 72 and all contract documents and specification requirements.
B. The system shall have Class A circuits for each floor. The system shall operate in the alarm mode upon actuation of any alarm initiating device. The system shall remain in the alarm mode until all initiating device(s) are reset and the fire alarm control panel is manually reset and restored to normal.
C. The system shall provide the following functions and operating features:
    1. The FACP and auxiliary power panels shall provide power, annunciation, supervision and control for the system.
    2. Provide Class A (formerly style 7) initiating device circuits.
    3. Provide Class A (Former Style 7) signaling line circuits for the network.
    4. Provide integrated fire and smoke management with firefighter's override functions.
    5. Provide Class A (formerly style 7) notification appliance circuits. Arrange circuits to allow individual, selective, and all-call voice and visual notification by zone. Notification Appliance circuits shall be zoned to correspond with the building fire barriers and other building features.
    6. Stair-towers: Each Stair-tower NAC shall be separately zoned
    7. Strobes shall be synchronized throughout the entire building.
    8. If a voice evacuation system is specified, the system amplifiers shall be configured as distributed, bulk, or a combination of distributed and bulk audio. If necessary, convenience paging and/or background music shall be available via UL-listed speakers. .
    9. Provide minimum of 2 channels for live and recorded voice messaging.
    10. Provide electrical supervision of the primary power (AC) supply, presence of the battery, battery voltage, and placement of system modules within the control panel.
D. Alarm functions shall override trouble or supervisory functions. Supervisory functions shall override trouble functions.
E. Fire alarm signal initiation shall be by one or more of the following devices:
    1. Manual pull station
    2. NEW Line of detectors including ASA line
    3. Duct smoke detector

4. Automatic sprinkler system water flow switch

F. Activation of any system fire, security, supervisory, trouble, or status initiating device shall cause the following actions and indications at all network Operating units using basic graphics and multiple detail screens.

1. Fire Alarm Condition:
   a. Sound an audible alarm and display a custom screen/message defining the building in alarm and the specific alarm point initiating the alarm in a graphic display.
   b. Log into the system history archives all activity pertaining to the alarm condition.
   c. Sound the ANSI 117-1 signal with synchronized audible and synchronized strobes throughout the facility.
   d. Audible signals shall be silenced from the fire alarm control panel by an alarm silence switch. Visual signals shall be programmable to flash until system reset or alarm silencing, as required.
   e. A signal dedicated to sprinkler system water flow alarm shall not be silenced while the sprinkler system is flowing at a rate of flow equal to a single head.
   f. The alarm information shall be displayed on a graphic annunciator located where shown on drawing.
   g. Activation of any smoke detector in a single elevator lobby or an elevator equipment room shall, in addition to the actions described, cause the recall of that bank of elevators to the main exit discharge and the lockout of controls. In the event of recall initiation by a detector in the main extinguishing discharge lobby, the recall shall be to the alternate floor as determined by the AHJ.
   h. Where indicated on drawings, heat detectors in elevator shaft and machine rooms shall activate an elevator power shunt trip breaker. The heat detectors shall be rated at a temperature below the ratings of the sprinkler heads in respective locations to ensure that the power shall be shut off before activation of sprinkler system.
   i. System operated duct detectors as per local requirements shall accomplish HVAC shut down.
   j. Door closure devices shall operate by fire barrier area, by floor, by local requirements or by local requirements.
   k. Send the event information to the Management Station with the device type and custom message.
2. Additional system operation for Fire Alarm Condition for Voice:
   a. Sound a pre-announce tone followed by a field programmable digitized custom evacuation message, on the floor of alarm, the floor below and the floor above. The visual signals shall operate in a similar pattern.
   b. A simultaneous message shall be delivered via all alarm speakers installed on the remaining floors indicating the requirement for occupants of these floors to remain alert for further instructions.
   c. A simultaneous message shall be delivered via all alarm speakers installed in stairways and elevators informing occupants of the imminent shutdown of elevator circuits and the expected high traffic load in the stairwells.
   d. An automatic announcement or tone evacuation signal shall be capable of interruption by the operation of the system microphone to give voice evacuation instructions overriding the pre-programmed sequences.
   e. Status lights next to speaker selection switches on the control panel shall indicate speaker circuit selection.

f. Audible signals shall be silenced from the fire alarm control panel by an alarm silence switch. Visual signals shall be programmed to flash until system reset or alarm silencing, as required by the AHJ.

3. Supervisory Condition:
   a. Display the origin of the supervisory condition report at the local fire alarm control panel graphic LCD display.
   b. Activate supervisory audible and dedicated visual signal.
   c. Audible signals shall be silenced from the control panel by the supervisory acknowledge switch.
   d. Record within system history the initiating device and time of occurrence of the event.
   e. Send the event information to the Management Station with the device type and custom message.
4. Trouble Condition
   a. Display at the local fire alarm control panel graphic LCD display, the origin of the trouble condition report.
   b. Activate trouble audible and visual signals at the control panel and as indicated on the drawings.
   c. Audible signals shall be silenced from the fire alarm control panel by a trouble acknowledge switch.
   d. Trouble conditions that have been restored to normal shall be automatically removed from the trouble display queue and not require operator intervention. This feature shall be software selectable and shall not preclude the logging of trouble events to the historical file.
   e. Trouble reports for primary system power failure to the master control shall be automatically delayed for a period of time equal to 25% of the system standby battery capacity to eliminate spurious reports as a result of power fluctuations.
   f. Record within system history: the occurrence of the event, the time of occurrence and the device initiating the event.
   g. Send the event information to the Management Station the device type and custom message.
5. Security Condition:
   a. Display at the local fire alarm control panel graphic LCD display, the origin of the security condition report. A dedicated security LED shall flash until the alarm has been acknowledged, then revert to a steady "ON" state.
   b. The control system shall be capable of bypassing the alarms from an individual security system installed within selected areas. The pass code allowing this function shall be assignable to individual security personnel and each bypass action shall be logged to system history. Intrusion alarms occurring during a bypass period shall be logged to history and displayed but no audible alarm shall occur at the control panel.
   c. The Local Fire Control Panel shall be UL 1076 listed for security purposes.

1.06 SUBMITTALS:

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and

accessories. Complete manufacturer's catalog data including supervisory power usage, alarm power usage, physical dimensions, and finish and mounting requirements.

B. Power calculations. Battery capacity calculations. Battery size shall be a minimum of 125% of the calculated requirement. Provide the following supporting information:
   1. Supervisory power requirements for all equipment.
   2. Alarm power requirements for all equipment.
   3. Power supply rating justification showing power requirements for each of the system power supplies. Power supplies shall be sized to furnish the total connected load in a worst-case condition plus 25% spare capacity.
   4. Voltage drop calculations for wiring runs demonstrating worst-case condition.
   5. NAC circuit design shall incorporate a 20% spare capacity for future expansion.

C. Submit manufacturer's requirements for testing Device Loop Card circuits and device addresses prior to connecting to control panel. At a minimum, the following tests shall be required: device address, the usage (alarm, supervisory etc), environmental compensation, temperature ratings for thermal detectors and smoke detector sensitivities. This requirement shall need approval before any wiring is connected to the control panel.

D. Shop Drawings: 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.
   3. Complete drawings covering the following shall be submitted by the contractor for the proposed system:
      a. Floor plans in a CAD compatible format at a scale of 1/8"=1'-0" showing all equipment and raceways, marked for size, conductor count with type and size, showing the percentage of allowable National Electric Code fill used.
      b. Provide a fire alarm system function matrix as referenced by NFPA 72, Figure A-7-5.2.2 (9). Matrix shall illustrate alarm input/out events in association with initiation devices. Matrix summary shall include system supervisory and trouble output functions. Include any and all departures, exceptions, variances or substitutions from these specifications and/or drawings at time of bid.
   4. Installation drawings, shop drawings, and as-built drawings shall be prepared by an individual experienced with the work specified herein.
   5. Incomplete submittals shall be returned without review, unless with prior approval of the Engineer.

E. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Light fixtures
   2. HVAC registers
   3. Fire protection equipment interfaces
   4. Special suppression system interfaces

F. Qualification Data: For qualified installer, applicator, manufacturer, fabricator, professional engineer, testing agency, and factory-authorized service representative.

G. Source quality-control reports.

H. Field quality-control reports.

I. Operation and Maintenance Data: For all fire alarm equipment, to include in operation and maintenance manuals.

J. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On magnetic media or compact disk, complete with data files.
   3. Device address list.
   4. Printout of software application and graphic screens.

1.07 QUALITY ASSURANCE:

A. Manufacturer Qualifications: The publications listed below form a part of this publication to the extent referenced. The publications are referenced in the text by the basic designation only. The latest version of each listed publication shall be used as a guide unless the authority having jurisdiction has adopted an earlier version.
   1. FM Global (Factory Mutual (FM)): FM Approval Guide
   2. National Fire Protection Association (NFPA)
      a. NFPA 70 National Electrical Code
      b. NFPA 72 National Fire Alarm Code
      c. NFPA 90A Standard for the Installation of Air Conditioning and Ventilating Systems
      d. NFPA 99 Health Care Facilities Code
      e. NFPA 13, and NFPA 25
      f. NFPA 720
      g. NFPA 101 Life Safety Code
   3. Underwriters' Laboratories, Inc. (UL) equipment standards, Latest Edition
      a. UL Fire Protection Equipment Directory
      b. UL Electrical Construction Materials Directory
      c. UL 38 – Manually Actuated Signaling Boxes for Use With Fire Protection Signaling Systems
      d. UL 228 – Door Holding Devices
      e. UL 268 - Smoke Detectors for Fire Protective Signaling Systems
      f. UL 268A - Smoke Detectors for Duct Application
      g. UL 464 - Audible Signal Appliances
      h. UL 497A – Secondary Protectors for Communications Circuits
      i. UL 521 - Heat Detectors for Fire Protective Signaling Systems
      j. UL 864 - Control Units for Fire Protective Signaling Systems
      k. UL 1076 – Security
      l. UL 1283 – Electromagnetic Interference Filters
      m. UL 1449 - Transient Voltage Surge Suppressors
      n. UL 1480 - Speakers for Fire Protective Signaling Systems
      o. UL 1971 - Signaling Devices for the Hearing Impaired
      p. UL 2572 – Mass Notification Systems
   4. Underwriters Laboratories Canada (ULC)
   5. International Code Council
      a. International Building Code
      b. International Fire Code
   6. State and Local Building Codes as adopted and/or amended by The Authority Having Jurisdiction, ADA, and/or State and local equivalency standards as adopted by The Authority Having Jurisdiction.
   7. ISO 9002.

B. Supplier Qualifications
   1. Provide the services of a factory trained and certified representative or technician, experienced in the installation and operation of the type of system provided. The representative shall be a minimum of NICET level 2 in Fire alarm and licensed in the State if required by law.
   2. The technician shall supervise installation, software documentation, adjustment, preliminary testing, final testing and certification of the system. The technician shall provide the required instruction to the owner's personnel in the system operation and maintenance.
   3. The factory trained service provider shall furnish evidence they have an experienced service organization, which carries a stock of spare and repair parts for the system being furnished.
   4. The manufacturer's representative shall be authorized and trained by the manufacturer to calculate, design, install, test, and maintain the air sampling system and shall be able to produce a certificate stating such upon request.

C. Installer Qualifications:
   1. Before commencing work, submit data showing that the manufacturer has successfully installed fire alarm systems of the same scope, type and design as specified.
   2. The contractor shall submit copies of all required Licenses and Bonds as required in the State having jurisdiction.
   3. The manufacturer representative shall employ on staff a minimum of one NICET certified designer, technician and/or a professional engineer, registered in the State of the installation, as required by the AHJ.
   4. Manufacturer's representatives unable to comply with the provisions of qualification of installers shall present proof of engaging the services of a subcontractor qualified to furnish the required services.

D. Testing Agency Qualifications: Qualified for testing indicated.

E. Source Limitations for fire alarm equipment: Obtain fire alarm equipment from single source.

F. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 50 or less.
   3. Combustion Characteristics: ASTM E 136.

G. 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.

H. Pre-installation Conference: Conduct conference at Project site.

1.08 DELIVERY, STORAGE, AND HANDLING:

A. Deliver products to project site in original, unopened packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, and shelf life if applicable.

B. Store materials inside, under cover, above ground, and kept dry and protected from physical damage until ready for use. Remove from site and discard wet or damaged materials.

1.09 PROJECT CONDITIONS:

A. Installed products or materials shall be free from any damage including, but not limited to, physical insult, dirt and debris, moisture, and mold damage.

B. Environmental Limitations: Do not deliver or install products or materials until spaces are enclosed and weather-tight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.10 WARRANTY:

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire alarm equipment that fail(s) in materials or workmanship within specified warranty period.

1. Warranty Period: 1 year from date of Substantial Completion.

1.11 EXTRA MATERIALS:

A. Furnish 10% extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. The parts should include, but are not limited to, main system equipment (motherboards, processors, cards, etc.) and peripheral components (field devices such as initiating devices and notification appliances).

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

1. Manufacturers: Siemens Desigo Modular with Voice Evacuation and Siemens Desigo CC Command Center.

2.02 CONTROL PANEL:

A. Software Modifications: The existing system structure and software shall place no limit on the type or extent of software modifications on-site. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being made.

B. The fire alarm control panel shall monitor the dedicated releasing panel for the single interlock preaction system.

2.03 REMOTE POWER SUPPLY FOR NON-VOICE NOTIFICATION APPLIANCES:

A. The PAD-5 power supply unit shall be used with a Siemens Desigo® Fire Safety Modular System. It shall an addressable NAC distributed controller to provide power to visual strobe circuits or supply auxiliary power to such items as Door holder circuits. The PAD-5 shall communicate on the SLC loop to the Siemens Desigo® Fire Safety Modular Control Panel. It shall provide status monitoring, device level fault indications and individual NAC control using a single address on the SLC. The PAD-5 unit shall provide a constant 24VDC nominal output voltage to each NAC-independent of voltage fluctuations on the primary or secondary power source.

B. The PAD-5 shall be a self-contained unit with 24VDC power supply and batteries housed in its own locked enclosure. Enclosure shall be made of 16 GA cold rolled steel, lockable and having the same key as the other control enclosures. Shall have 2 sizes (1 unit and a 2 unit) and colors (red and black).

C. The power supply shall be UL 864 listed and available in 6A and 9A models and 120 or 240VAC.

D. The power supply be able to support up to 18AH batteries in a single unit and 35AH in a 2-unit enclosure. Shall be able to support up to 100AH batteries in a separate enclosure.

E. The power supply shall have four independent 3 amp rated NAC circuits, expandable to a total of eight (8) Class B or four (4) Class A circuits or a mixture of each with an expansion CLSA card.
F. The power supply shall be a class X isolating device residing on the SLC loop.
G. Each NAC output can be configured as an Aux Power output or a non-alarm closure input circuit.
H. Complete status monitoring to the individual circuit level at the main FACP and on-board LED status and diagnostic indicators.
I. The PAD-5 is fully configurable through the Siemens Fire Safety Modular system configuration tool.
J. Output Circuits can be configured individually as Steady On, Temp 3, Temp 4, March Time 30, 60 or 120 PPM.
K. All NAC circuits have synchronized strobe outputs, any combination of PAD-5 Main Boards and Expansion cards up to 32 can be synchronized on the same XDLC loop.
L. A dedicated Bell Follower circuit can be used to achieve synchronization across multiple SLC loops.
M. Shall be able to accept a range of End of the Line (EOL) resistor values (2.2K to 24KΩ) without having to program or configure unit.

2.04 MAGNETIC DOOR HOLDERS:

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
   1. Electromagnets: Require no more than 3 W to develop 25-lbf (111-N) holding force.
   2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
   3. Rating: 24-V ac or dc.
B. Material and Finish: Match door hardware.

2.05 INTELLIGENT INITIATING DEVICES:

A. General
   1. All initiation devices shall be insensitive to initiating loop polarity. Specifically, the devices shall be insensitive to plus/minus voltage connections.
B. Smoke Detectors –S-Line Addressable FDOO-Series
   1. The detectors shall be guaranteed in writing not to false alarm when configured by the factory trained certified technician. The detectors must provide at least 19 different environmental algorithms that allow the detector to provide superior false alarm immunity without the need for additional alarm verification delays.
   2. The detectors shall have a tri-color LED to streamline system maintenance/inspection by plainly indicating detector status as follows: green for normal operation, amber for maintenance required, red for alarm.
   3. Detectors shall utilize state of the art forward/backward light scattering technology, with improved detection for smoldering and flaming fire signatures. The detectors shall replace the need for ionization detectors due to improved response characteristics to flaming fires.
   4. When required, the detectors shall incorporate an addressable Carbon Monoxide (CO) sensor. The CO sensor shall be selectable as an input to the multi-criteria fire detector algorithm and as an independent life-safety CO gas detector (in compliance with NFPA 720).
   5. Detectors shall provide pre-alarm signal at 0.2% obscuration/ft. and a full alarm at 1.0% obscuration/ft. to meet the performance requirements of National Fire Protection

Association Standard 76, Fire Protection of Telecommunications Facilities as a Very Early Warning Fire Detector (VEWFD).

6. The forward/backward light scattering technology shall provide improved immunity to spurious activation (deceptive phenomena). The detectors shall have a "No False Alarm Guarantee".
7. The detectors shall be RoHS-compliant: it shall meet standards for Reduction of Hazardous Substances (RoHS) by reduction in lead content and other restricted substances.
8. The multi-criteria detector with CO input shall be UL 2075 compliant as a gas and vapor detector.
9. The multi-criteria fire detectors shall be an intelligent digital photoelectric detector with a programmable heat detector. Detectors shall be listed for use as open area protective coverage, in-duct installation and sampling assembly installation and shall be insensitive to air velocity changes. The detectors' communications shall allow the detectors to provide alarm input to the system and alarm output from the system within four (4) seconds. So as to minimize the effort required by the installing and maintenance technician to appropriately configure the detector to ensure optimal system design, the detectors shall be programmable as application specific. Application settings shall be selected in software for a minimum of 19 environmental fire profiles unique to the devices installed location.
10. The detectors shall be designed to eliminate the possibility of false indications caused by dust, moisture, RFI/EMI, chemical fumes and air movement while factoring in conditions of ambient temperature rise, obscuration rate changes and hot/cold smoke phenomenon into the alarm decision to give the earliest possible real alarm condition report.
11. The detectors shall be capable of being field programmed for simultaneous and /or independent functionality, depending on the application. For example, the detectors shall be capable of utilizing the optical, heat, and/or CO sensors together for enhanced fire detection (multi-criteria) and simultaneously provide independent outputs for CO gas life-safety, smoke, and heat detection. Any combination of the sensors is possible.
12. The detectors shall be UL listed for operation in a 95% relative humidity (RH) environment.
13. The detectors shall be designed to eliminate calibration errors associated with field cleaning of the chamber.
14. The detectors shall support the use of a relay, or LED remote indicator without requiring an additional software address. Low profile, white case shall not exceed 2.5 inches of extension below the finish ceiling.
15. The detectors shall support the use of an ambient temperature warning signal at the panel. This temperature shall be user-configurable for the set temperature of the warning and the event type generated by the warning. This event can be used to trigger system logic.
16. The multi-criteria detector with CO sensor shall support the use of an ambient Carbon Monoxide (CO) warning signal at the panel. This ambient CO level shall be user-configurable in parts per million (PPM) for the set threshold of the warning and event type generated by the warning. This event can be used to trigger system logic.
17. For the detectors where required, there shall be available a locking kit and detector guard to prevent unauthorized detector removal.
18. UL Listed as "direct in-duct" mounting.
19. Available models:

a. FDOOT441. Multi-Criteria incorporating 2 Optical sensors and 2 Thermal sensors with an operating temperature range of 32µF to 120°F. Nineteen selectable profiles. Polarity insensitive installation wiring. Three color LED.
b. FDOOTC441. Multi-Criteria incorporating 2 Optical sensors, 2 Thermal sensors, and Carbon Monoxide sensing technologies with an operating temperature range of 32°F to 120°F. Twenty-Five selectable profiles. Polarity insensitive installation wiring. Three color LED. CO sensor may be programmed as part of the multi-criteria, or may be an independent CO detector.

C. Duct Smoke Detectors – Addressable
1. For duct detector applications, the smoke detector shall be an intelligent digital photoelectric detector. Detectors shall be listed for use as open area protective coverage, in duct installation and sampling assembly installation and shall be insensitive to air velocity changes.
2. The detector communications shall allow the detector to provide alarm input to the system and alarm output from the system within four (4) seconds. The detector shall be mounted in a duct detector housing listed for that purpose. The duct detector shall support the use of a remote test switch, relay or LED remote indicator. The duct detector shall be supplied with the appropriate sampling tubes to fit the installation.
3. Where duct detectors are exposed to the weather a weatherproof enclosure shall be available. A NEMA-3R and NEMA-4X option shall be available. The duct housing cover shall include a test port for functional testing of the detector without cover removal. The duct housing shall include a cover removal switch capable of indicating cover removal status to the fire alarm control panel.
4. The intelligent duct detector shall have a model number from the FDBZ-Series. Where required there shall be available a duct housing with an on-board relay. Also where required, there shall be a standalone housing available with its own power supply and test/reset switch that does not require connection to a fire alarm control panel. It shall be model FBZ492-PR.
5. Duct smoke detector housing shall allow use in duct systems with air velocity ranging from 100 to 4,000 feet per minute, within temperature ranges of 32°F to 120°F per minute, and with relative humidity ranging from 0 to 95%.
6. Duct Housings and Accessories:
   a. FDBZ492 Global Air Duct Housing for Conventional and Addressable Detectors
   b. FDBZ492-HR Global Air Duct Housing for Addressable P2 Detectors with Relay Application
   c. FDBZ492-R Global Air Duct Housing for Conventional Detectors with Relay Application
   d. FDBZ492-RP Global Air Duct Housing for Conventional Detectors with Relay Application and Built-in Power Source
   e. FDBZ-WP Weather-Proof housing to accommodate all versions of Global Air Duct Housings
   f. FDBZ-RTL Remote Test Lamp for Conventional Detectors

D. Detector Bases – Addressable
1. Detector bases shall be low profile twist lock type with screw clamp terminals and self-wiping contacts. Bases shall be installed on an industry standard, 4" square or octagonal electrical outlet box.

2. Multi-Criteria Fire Detector Model FDOOTC441 shall be listed as providing CO detection in duct application.
3. The model number for the standard base shall be DB-11 - 6" Version.
4. The model number for the standard base shall be DB-11E - 4" Version.

E. Manual Pull Stations – Addressable
1. Provide addressable manual stations where shown on the drawings, to be flush or surface mounted as required. Manual stations shall contain the intelligence for reporting address, identity, alarm and trouble to the fire alarm control panel. The manual station communications shall allow the station to provide alarm input to the system and alarm output from the system within less than four (4) seconds.
2. The manual station shall be equipped with terminal strip and pressure style screw terminals for the connection of field wiring. Surface mounted stations where indicated on the drawings shall be mounted using a manufacturer's prescribed matching red enamel outlet box.
3. The double action pull station shall be model number XMS-D. It shall provide built-in isolation capability. The operator display shall indicate which specific device has detected a wiring fault on the data communication line.
4. Where required, there shall also be available pull stations with break glass, capable of explosion proof installation, capable of weatherproof installation, reset key operation, and metal housings.

F. Adressable Interface Devices
1. Addressable Interface Devices shall be provided to monitor inputs (contacts) and control outputs (relays) to and from the fire alarm system and associated devices. These interface devices shall be able to monitor single or dual contacts. An address will be provided for each contact. Where remote supervised relay is required the interface shall be equipped with a SPDT relay rated for 4 amps resistive and 3.5 amps inductive. The addressable interface modules shall be model FDCIO Series, XTRI Series, ILED-X series, TSM-1X or HCP series.
2. Where needed, a Conventional Zone Module shall connect to the Signal Line Circuit, which will allow the use of conventional initiation devices. This module shall have the ability to support up to 15 conventional smoke detectors and an unlimited number of contact devices. The module shall be model HZM.
3. Model XTRI Series shall provide input and outputs as needed by specific model number. The device shall also provide built-in isolation capability. The operator display shall indicate which specific device has detected a loop short on the data communication line.
4. Model FCIO422 addressable input/output module shall be insensitive to polarity and shall have capability for up to 4 separate inputs (Class B) or 2 separate Class A inputs and 4 separate outputs (Class B).
5. Model ILED-X addressable remote LED alarm indicators shall provide a visual notification for remote or concealed initiating devices. The device shall also provide built-in isolation capability.
6. Model TSM-1X addressable remote test switch shall provide an addressable normally open (N.O.) momentary switch with a tricolor light-emitting diode (LED) indicator. The LED indicator shall provide visual notification of the status of the tested device. The device shall also provide built-in isolation capability.
7. Model HCP addressable control point shall provide remote, independent control of a single device

8. Monitoring applications include (but not limited to):
   a. Water-flow switches
   b. Tamper switches
   c. Damper position
   d. Conventional devices (e.g. Smoke detectors, heat detectors, etc.)
   e. Duct Detectors
9. Control applications include (but not limited to):
   a. Notification appliance circuits (NAC)
   b. Speaker zones.
   c. Damper position
   d. Solenoids for sprinklers
10. Where applicable, all interface devices shall meet NFPA 72 Class X requirements for survivability.

2.06 ADVANCED FIRE ALARM NOTIFICATION APPLIANCES (LED based):

A. Series SLSPW and SLSPSW Wall Mount Speakers and Speaker/Strobes
1. The SL-Series high fidelity speaker appliances shall be Siemens SLSPW Speaker and SLSPSW speaker/strobes for wall-mount applications
2. The speakers shall be UL Listed under UL 1480 for Fire Protective Service
3. Speakers equipped with strobes shall be listed under UL 1971 for Emergency Devices for the Hearing-Impaired.
4. In addition, the speaker/strobes shall meet the requirements of FCC Part 15 and ICES-003.
5. All speakers shall be designed for a field selectable input of either 25 or 70 VRMS, with selectable power taps from 1/8 watt to 2 watts.
6. All models shall have listed sound output of up to 87 dB at 10 feet and a listed frequency response of 300 to 8000 Hz.
7. All inputs shall employ terminals that accept #12 to #18 AWG wire sizes
8. The series SLSPSW Speaker/Strobe appliances shall produce a flash rate of one (1) flash per second over the Regulated Voltage Range and shall incorporate a Light Emitting Diode (LED) as the light source with a rugged Lexan® lens.
9. The LED strobe flash duration shall be 20 ms.
10. Where Multi-Candela appliances are specified, the strobe intensity shall have 4 field selectable settings at 15, 30, 75, 110 candela for wall mount applications.
11. The selector switch for selecting the candela shall be tamper resistant.
12. Appliances with candela settings shall show the candela selection in a visible location at all times when installed.
13. The series SLSPW and SLSPSW shall be designed for indoor surface or flush mounting.
14. Mounting options shall include LED speaker backboxes and to standard 4” square, 2 1/8” deep backboxes.
15. The speaker and speaker/strobes shall incorporate a speaker mounting plate with a Snap-On grille cover and shall mount to standard electrical hardware requiring no additional trimplate or adapter.
16. All notification appliances shall be backwards compatible with Siemens legacy notification appliances.
17. The SLSPW wall model shall have a low profile measuring 6.1” H x 4.56” W x 1.29” D.
18. The SLSPSW wall model shall have a low profile measuring 6.1” H x 4.56” W x 1.4” D.
19. Finish shall be red or white.

20. Special lettering shall be available.
21. The speaker shall be listed to the low frequency requirements of UL 464 (520 Hz) to meet NFPA's 520 Hz tone requirements for sleeping areas.
22. Synchronization is possible when using the DSC sync modules, Desigo® Modular panel, FC901, FC2025-2050, FV2025-2050, or PAD SERIES power supply with built-in sync protocol
23. The strobes shall not drift out of synchronization at any time during operation. If the sync protocol fails to operate, the strobe shall revert to a non-synchronized flash rate and still maintain (1) flash per second over its Regulated Voltage Range.
24. The appliance shall also be designed so that the audible signal may be silenced while maintaining strobe activation

B. Series SLSPC and SLSPSC Ceiling Mount Speakers and Speaker/Strobes
1. The SL-Series high fidelity speaker appliances shall be Siemens SLSPC Speaker and SLSPSC speaker/strobes for ceiling-mount applications
2. The speakers shall be UL Listed under UL 1480 for Fire Protective Service
3. Speakers equipped with strobes shall be listed under UL 1971 for Emergency Devices for the Hearing-Impaired.
4. In addition, the speaker/strobes shall meet the requirements of FCC Part 15 and ICES-003.
5. All speakers shall be designed for a field selectable input of either 25 or 70 VRMS, with selectable power taps from 1/8 watt to 2 watts.
6. All models shall have listed sound output of up to 87 dB at 10 feet and a listed frequency response of 300 to 8000 Hz.
7. All inputs shall employ terminals that accept #12 to #18 AWG wire sizes
8. The series SLSPSC Speaker/Strobe appliances shall produce a flash rate of one (1) flash per second over the Regulated Voltage Range and shall incorporate a Light Emitting Diode (LED) as the light source with a rugged Lexan® lens.
9. The LED strobe flash duration shall be 20 ms.
10. Where Multi-Candela appliances are specified, the strobe intensity shall have 4 field selectable settings at 15, 30, 75, 95 candela for ceiling mount applications.
11. The selector switch for selecting the candela shall be tamper resistant.
12. Appliances with candela settings shall show the candela selection in a visible location at all times when installed.
13. The series SLSPC and SLSPSC shall be designed for indoor surface or flush mounting.
14. Mounting options shall include LED speaker surface backboxes and to 4" square, 2 1/8" deep backboxes
15. The speaker and speaker/strobes shall incorporate a speaker mounting plate with a snap-on grille cover and shall mount to standard electrical hardware requiring no additional trim plate or adapter.
16. All notification appliances shall be backwards compatible with Siemens legacy notification appliances.
17. The SLSPC and SLSPSC ceiling models shall have a low profile measuring 6.26" Diameter with 1.5" D.
18. Finish shall be red or white.
19. Special lettering shall be available.
20. The speaker shall be listed to the low frequency requirements of UL 464 (520 Hz) to meet NFPA's 520 Hz tone requirements for sleeping areas.

21. Synchronization is possible when using the DSC sync modules, Desigo® Modular panel, FC901, FC2025-2050, FV2025-2050, or PAD SERIES power supply with built-in sync protocol
22. The strobes shall not drift out of synchronization at any time during operation. If the sync protocol fails to operate, the strobe shall revert to a non-synchronized flashrate and still maintain (1) flash per second over its Regulated Voltage Range.
23. The appliance shall also be designed so that the audible signal may be silenced while maintaining strobe activation.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Perform work in accordance with the requirements of NFPA 70, NFPA 72, NFPA 13, NFPA 2001, and NECA 1-2006, Standard of Good Workmanship in Electrical Contracting.
B. Fasten equipment to structural members of building or metal supports attached to structure, or to concrete surfaces.
C. In the event that limited energy cable installation is allowed, all cable runs shall be run at right angles to building walls, supported from structure at intervals not exceeding 3 feet and where installed in environmental air plenums, be rated for such use and tied/supported by components listed for environmental air plenums installation.
D. Wiring Method: Install cables in raceways except within consoles, cabinets, desks, and counters Conceal raceway and cables except in unfinished spaces. Circuit Integrity cable may be run exposed and in dedicated cable trays.
E. Wiring Integrity and survivability requirements – Specify on shop drawings per NFPA72, Chapter 12
F. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
G. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.
H. Provide primary power for each panel from normal/ emergency panels as indicated on the Electrical Power Plans. Power shall be 120V AC service, transformed through a two-winding, isolation type transformer and rectified to low voltage DC for operation of all circuits and devices.

3.02 BOXES, ENCLOSURES AND WIRING DEVICES:

A. Boxes shall be installed plumb and firmly in position.
B. Extension rings with blank covers shall be installed on junction boxes where required.
C. Junction boxes served by concealed conduit shall be flush mounted.
D. Upon initial installation, all wiring outlets, junction, pull and outlet boxes shall have dust covers installed. Dust covers shall not be removed until wiring installation when permanent dust covers or devices are installed.
E. A "Fire alarm system" decal or silk-screened label shall be applied to all junction box covers.
F. Panel enclosures shall be installed to meet clearance requirements per NFPA 70 and local codes. Minimum requirements shall be 3-foot clearance in front of the enclosure

3.03 CONDUCTORS:

A. Each conductor shall be identified as shown on the drawings at each with wire markers at terminal points. Attach permanent wire markers within 2 inches of the wire termination. Marker legends shall be visible.

B. All wiring shall be supplied and installed in compliance with the requirements of the National Electric Code, NFPA 70, Article 760, and that of the manufacturer.

C. Wiring for strobe and audible circuits shall be a minimum 14 AWG, signal line circuits; 18 AWG twisted shielded, speaker circuits; 18 AWG twisted, telephone circuit; 18 AWG twisted shielded.

D. Wiring for pre-action releasing shall be in accordance with NFPA 13 and NFPA 2001

E. All splices shall be made using solder-less connectors. All connectors shall be installed in conformance with the manufacturer recommendations.

F. Crimp-on type spade lugs shall be used for terminations of stranded conductors to binder screw or stud type terminals. Spade lugs shall have upset legs and insulation sleeves sized for the conductors.

G. The installation contractor shall submit for approval prior to installation of wire, a proposed color code for system conductors to allow rapid identification of circuit types.

H. Wiring within sub panels shall be arranged and routed to allow accessibility to equipment for adjustment and maintenance.

3.04 DEVICES:

A. Relays and other devices to be mounted in auxiliary panels are to be securely fastened to avoid false indications and failures due to shock or vibration.

B. Wiring within panels shall be arranged and routed to allow accessibility to equipment for adjustment and maintenance.

C. All devices and appliances shall be mounted to or in an approved electrical box.

3.05 IDENTIFICATION:

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in DIVISION 26 SECTION "IDENTIFICATION FOR ELECTRICAL SYSTEMS."

B. Permanently label or mark each conductor at both ends with permanent alphanumeric wire markers.

C. A consistent color code for fire alarm system conductors throughout the installation.

3.06 FIELD QUALITY CONTROL:

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Testing General:

1. All Alarm Initiating Devices shall be observed and logged for correct zone and sensitivity. These devices and their bases shall be tagged with adhesive tags located in an area not visible when installed, showing the initials of the installation technician and date.
2. Wiring runs shall be tested for continuity, short circuits and grounds before the system is energized. Resistance, current and voltage readings shall be made as work progresses.
3. The acceptance inspector shall be notified before the start of the required tests. All items found at variance with the drawings or this specification during testing or inspection by the acceptance inspector shall be corrected.

4. Test reports shall be delivered to the acceptance inspector as completed.
5. All test equipment, instruments, tools and labor required to conduct the system tests shall be made available by the installation contractor. The following equipment shall be a minimum for conducting the tests:
    a. Ladders and scaffolds as required to access all installed equipment.
    b. Multi-meter for reading voltage, current and resistance.
    c. Two-way radios and flashlights.
    d. A manufacturer recommended device for measuring air flow through air duct smoke detector sampling assemblies.
    e. Decibel meter
    f. Intelligibility meter
    g. In addition to the testing specified to be performed by the installing contractor, the installation shall be subject to testing by the authority having jurisdiction.

3.07 ACCEPTANCE TESTING:

A. A written acceptance test procedure (ATP) for testing the fire alarm system components and installation will be prepared by the engineer in accordance with NFPA 72 and this specification. The contractor shall be responsible for the performance of the ATP, demonstrating the function of the system and verifying the correct operation of all system components, circuits, and programming.

B. A program matrix shall be prepared by the installing contractor referencing each alarm input to every output function affected as a result of an alarm condition on that input.

C. The installing contractor prior to the ATP shall prepare a complete listing of all device labels for alphanumeric annunciator displays.

D. Loop Resistance Tests: Measure and record the resistance of each circuit with each pair of conductors in the circuit short-circuited at the farthest point from the circuit origin. The tests shall be witnessed by the owner and test results recorded for use at the final acceptance test.

E. Preliminary Testing: Conduct preliminary tests to ensure that all devices and circuits are functioning properly. After preliminary testing is complete, provide a letter certifying that the installation is complete and fully operable. The letter shall state that each initiating and indicating device was tested in place and functioned properly. The letter shall also state that all panel functions were tested and operated properly. The Contractor and an authorized representative from each supplier of equipment shall be in attendance at the preliminary testing to make necessary adjustments.

F. Testing requirements for pre-action systems in accordance with NFPA13

G. Final Acceptance Test: Notify the owner in writing when the system is ready for final acceptance testing. Submit request for test at least 30 calendar days prior to the test date. A final acceptance test will not be scheduled until the loop resistance test results, and the submittals required in Part 1 are provided to the owner. Test the system in accordance with the procedures outlined in NFPA 72.
    1. Verify that the control unit is in the normal condition as detailed in the manufacturer's operating and maintenance manual.
    2. Test each initiating and indicating device and circuit for proper operation and response. Disconnect the confirmation feature for smoke detectors during tests to minimize the amount of smoke or test gas needed to activate the detector.
    3. Test the system for all specified functions in accordance with the contract drawings and specifications and the manufacturer's operating and maintenance manual.

4. Visually inspect all wiring
5. Verify with all parties the required survivability of wiring, raceways, and junction boxes
6. Verify that all software control and data files have been entered or programmed into the FACP.
7. Verify that Shop Drawings reflecting as-built conditions are accurate. Upon final approval by all parties, provide two sets of AS-built documents in a cabinet adjacent to the main FACP or designated area within the building. Per NFPA 72 7.7.2Measure the current in Notification appliance circuits under full load to assure that there is the calculated spare capacity for every circuit.
8. Measure voltage readings for circuits to assure that voltage drop does not exceed specified design requirements.
9. Field Verify and measure the voltage drop at the most remote appliance on each notification appliance circuit.

H. The acceptance inspector shall use the system record drawings in combination with the documents specified in this specification during the testing procedure to verify operation as programmed. In conducting the ATP, the acceptance inspector shall request a demonstration of any or all input and output functions. The items tested shall include but not be limited to the following:
   1. System wiring shall be tested to demonstrate correct system response and correct subsequent system operation in the event of:
      a. Open, shorted and grounded signal line circuits.
      b. Open, shorted and grounded notification, releasing circuits.
      c. Primary power or battery disconnected.
   2. System notification appliances shall be demonstrated as follows:
      a. All alarm notification appliances actuate as programmed
      b. Audibility and visibility at required levels.
      c. VOICE Intelligibility measurements at the time of commissioning and with a follow up inspection six months after substantial competition to verify conditions
   3. System indications shall be demonstrated as follows:
      a. Correct message display for each alarm input at the control display.
      b. Correct annunciator light for each alarm input at each annunciator and graphic display as shown on the drawings.
      c. Correct history logging for all system activity.
   4. System off-site reporting functions shall be demonstrated as follows:
      a. Correct zone transmitted for each alarm input
      b. Trouble signals received for disconnect
   5. Secondary power capabilities shall be demonstrated as follows:
      a. System primary power shall be disconnected for a period of time as specified herein. At the end of that period, an alarm condition shall be created and the system shall perform as specified for a period as specified.
      b. System primary power shall be restored for forty-eight hours and system-charging current shall be normal trickle charge for a fully charged battery bank.
      c. System battery voltages and charging currents shall be checked at the fire alarm control panel.

3.08 DOCUMENTATION:

A. System documentation shall be furnished to the owner and shall include but not be limited to the following:

1. System record drawings and wiring details including one set of reproducible drawings, and a CD ROM with copies of the record drawings in DXF format for use in a CAD drafting program.
2. System operation, installation and maintenance manuals.
3. System matrix showing interaction of all input signals with output commands.
4. Documentation of system voltage, current and resistance readings taken during the installation, testing and ATP phases of the system installation.
5. System program showing system functions, controls and labeling of equipment and devices.
6. All applicable NFPA 72 commissioning reports.

3.09 PROTECTION:

A. Remove and replace devices and panel components that are wet, moisture damaged, or mold damaged.

3.10 DEMONSTRATION:

A. Instructor: Include in the project the services of an instructor, who shall have received specific training from the manufacturer for the training of other persons regarding the inspection, testing and maintenance of the system provided. The instructor shall train the employees designated by the owner in the care, adjustment, maintenance, and operation of the fire alarm system.

B. Training sessions shall cover all aspects of system performance, including system architecture, signaling line circuit configurations, sensor and other initiating device types, locations, and addresses, fire alarm control panel function key operation, and other functions as designated by the owner.

C. Required Instruction Time: Provide 16 hours of instruction after final acceptance of the system. The instruction shall be given during working hours on such dates and times as are selected by the owner. The instruction may be divided into two or more periods at the discretion of the owner. One training session shall be videotaped by the contractor. Required owner format shall be delivered to the owner.

D. Comprehensive system troubleshooting training shall be provided for a single individual designated by the owner. This session shall be separate and distinct from the above-described sessions.

E. All training sessions shall be conducted following final system certification and acceptance. Three additional training sessions shall be provided for all security personnel on all shifts six months after final system certification.

F. All training sessions shall be conducted by an authorized fire alarm system distributor representative, who has received specific training from the manufacturer for the training of other persons regarding the inspection, testing, and maintenance of the system provided.

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